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THESIS

CORRELATION BETWEEN QUALITY MANAGEMENT METRIC AND PEOPLE CAPABILITY MATURITY MODEL by Franz-Dietmar Dahmann September 2003   Thesis Co-Advisors: John Osmundson   J. Bret Michael

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**CORRELATION BETWEEN QUALITY MANAGEMENT METRIC
AND PEOPLE CAPABILITY MATURITY MODEL**

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ABSTRACT

The quality of software management in a development project is a major factor in determining the success of a project. The four main areas in which a software project manager can affect the outcome of a project are people management, requirements management, estimation/planning management and risk management. People management is the management area with the highest influence on project success.

In this thesis a quality management metric (QMM) was evaluated with respect to its conformance with an established people capability maturity model (P-CMM). The survey elements of the QMM were mapped to the processes described in the maturity model. The analysis indicates a high level of conformance of the QMM with the P-CMM. The results of applying the QMM can be used to characterize the quality of software management. Based on the correlation of QMM survey elements to processes of the maturity model, the results can then be used to identify processes that need improvement to increase the likelihood of program success.

Future work includes further refining and assessing the QMM. As new models in the field of software development management evolve, the QMM will need to be re-evaluated with respect to these new models.

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EXECUTIVE SUMMARY

The quality of software management in a development project is a major factor in determining the success of a project. The four main areas in which a software project manager can affect the outcome of a project are people management, requirements management, estimation/planning management and risk management. People management is the management area with the highest influence on project success.

In this thesis a quality management metric (QMM) was evaluated with respect to its conformance with an established people capability maturity model (P-CMM). The survey elements of the QMM were mapped to the processes described in the maturity model. The analysis indicates a high level of conformance of the QMM with the P-CMM except for objective – and purpose – related differences. The QMM questionnaire covers all processes of the P-CMM with relevancy for project management and is applicable as a quantitative performance measurement tool.

The results of applying the QMM can be used to characterize the quality of software management. Based on the correlation of QMM survey elements to processes of the maturity model, the results can then be used to identify processes that need improvement to increase the likelihood of program success.

Future work includes further refining and assessing the QMM. As new models in the field of software development management evolve, the QMM will need to be re-evaluated with respect to these new models.

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I. INTRODUCTION AND BACKGROUND

A. PROBLEM STATEMENT

Software has grown tremendously important over the past decades. Information technology is present in almost all technical systems, and the capabilities, as well as properties, of technical systems are increasingly determined by software. A new technical system's success depends increasingly on the development of appropriate software, which can be an extremely complex enterprising comprising millions of lines of code [GAO 93].

Managing software development presents difficulties and risks beyond those found in the development of non-software products. Software is more complex per dollar spent than other engineering products [Osmundson 02b] and developmental problems cannot be treated, as would hardware manufacturing issues, because software, lacking a concrete existence, is not susceptible to physically testing or visual appraisal. Unlike hardware fabrication, which is based on blueprints, the task of implementing product specifications as software algorithms is a creative process continually in danger of misinterpretation. Because the flexible nature of software often allows changes throughout the developmental process, and, moreover, unforeseen difficulties may require deviations from the initial set of requested features, customers may be tempted to change their requirements as development progress—especially as they note discrepancies between their assumed expectations and the way they are interpreted and implemented. Managing software development commonly includes dealing with this phenomenon (known as "creeping requirements") and the costs and scheduling fallout that may result. Requirement management, as well as estimation/planning and risk management, has to be an integral part of managing a software project.

Software development is a creative act performed by educated professionals whose skill and performance may vary greatly. In general, the best performers will be about three times as productive as the average performer

[Osmundson 02b]. To achieve maximum productivity, these developers deserve proper leadership to sustain motivation and inspiration.

Though each programmer fulfills individual tasks, communication among the team is vital to successful development. Complex software requires intensive interaction between different program parts, requiring tight coordination in the work of individuals. Communication is also necessary between developer and customer to avoid misinterpretation of product requirements and assure that the final product is what the customer needs and wants. The program manager has to ensure proper communication within the development team and among all external stakeholders by ensuring effective people management, the aim of which is to allocate human resources appropriately, facilitate and institutionalize necessary communications, and provide leadership to the team.

Successful development of software depends on numerous factors. Different development methods may be used and organization of the effort may take various forms. But while software-development methods have evolved over time in an attempt to enhance the prospects of project success, the results are still dissatisfying. More than fifty percent of software projects cost nearly ninety percent over their original estimates; the majority of software projects finish either over time or over budget [STSC 00, Osmundson 02a]; and about a third of all projects are cancelled [Osmundson 02b]. The factor most affecting project failure is deficient management. Barry Boehm [Boehm 81] stated in 1981,

> Poor management can increase software costs more rapidly than
> any other factor.

Twenty years later, this statement is still true. Poor management is seen as the primary cause of failure in the development of software-intensive systems [STSC 00]. Shortfalls in people management pose severe project risks [Boehm 87], and accordingly people management is seen as the most important part of software-development management [Chatzoglou 96, Machniak 99, Grossmann 00].

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To achieve success, software-development management must address four areas of focus:

- Risk management
- Requirements management
- Estimation/planning management
- People management

Over the years, models have been built to describe how organizations deal with the task of software development. One dominant model is the Software Capability Maturity Model (SW-CMM) [PAULK 93]. SW-CMM categorizes levels of maturity of development processes and describes associated abilities and tasks. Other models derived from the SW-CMM address integration or contracting aspects. But with people management most crucial to successful software-development, the People Capability Maturity Model (P-CMM) [Curtis 01], which addresses the problems of managing an organization's workforce, is of especial note. The P-CMM proposes specific practices and processes at differing maturity levels; at the predictable maturity level (level 4), measurement actions addressing quantitative performance management are proposed. However, the P-CMM does not provide specific metrics or tools.

With management a dominant factor in the success of software development, obtaining an accurate evaluation of management quality is a key means of predicting project success. The results of such evaluations can be used to devise corrective actions, thus improving the probability of overall success and reducing the impact of adverse conditions and risks.

The Quality Management Metric (QMM) developed by Martin Machniak [Machniak 99] proposes a questionnaire for use in evaluating the quality of software-project management to improve performance. Much emphasis of the QMM centers on people management. Verification and validation of the QMM yields a positive correlation between a QMM score and overall program success [GROSSMANN 00]. However, despite these encouraging results, the QMM has not been applied to projects other than those used for its verification and validation. A major reason is that the QMM concentrates on management areas

and processes and activities within these management areas, implementing various aspects looked at by the capability maturity models; but up to now it has lacked correlation to specific maturity levels. This leaves organizations and program managers doubtful whether it is applicable in their specific situation.

The P-CMM, on the other hand, describes abilities required to perform activities at different maturity levels. Activities associated with a specific maturity level can be performed on lower maturity levels as well, but will be hampered by lack of underlying skills. Processes from a higher maturity level cannot reach their full potential until the proper foundation is laid [Paulk 93]. The question arises whether the QMM can be used to measure people-management performance at the predictable maturity level of the P-CMM. To answer this question, the conformity of the QMM with the P-CMM must be analyzed.

B.   SOLUTION PATH

The P-CMM [Curtis 01] serves as a model of best practices for managing an organization's workforce. Quantitative performance management is described as a process area at the predictable maturity level, including the use of measurements to determine the status and performance of management activities. However, specific metrics or tools are not provided within the P-CMM.

The QMM developed by Martin Machniak [Machniak 99] proposes a questionnaire that can be used to measure the quality of management of software-development projects and with that information to improve software-management performance. One of the areas addressed in the questionnaire is people management within the management of software development.

The QMM therefore is a candidate for performing quantitative measurement of people management performance at the predictable maturity level of the P-CMM. It can be established as a metrics tool at this level if it conforms to the requirements on measurement raised at the predictable maturity level in the P-CMM. This needs to be analyzed and evaluated.

C.   SCOPE OF THE RESEARCH

The QMM covers management of requirements, estimation/planning, risk, and people. Of these, people management is seen as its most important component with the highest impact on success probability [Machniak 99].
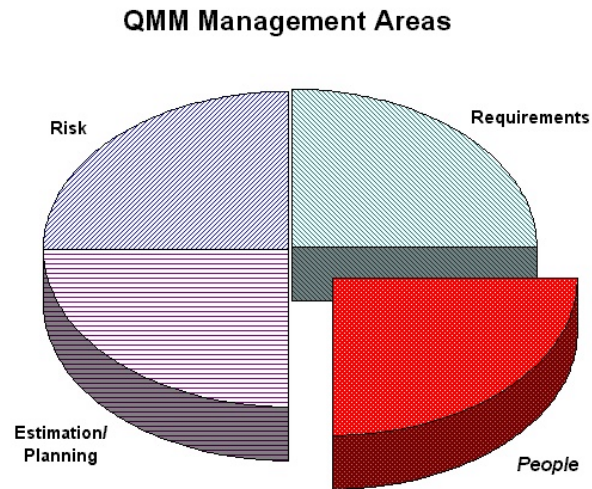
Figure 1.   QMM Management Areas

In view of that the people management area is also the one specifically addressed by a specific model (P-CMM) derived from the SW-CMM. This thesis will therefore focus on the people management aspect of the QMM. It will analyze the questionnaire's conformity with quantitative-performance management measurements at the predictable maturity level in the P-CMM.

D.   ORGANIZATION

Chapter II first discusses the QMM as an instrument for measuring software-management quality. Special emphasis is given to measuring people-management quality as an important component of software development management. It then discusses the P-CMM as a model of practices that improve the capabilities of an organization's workforce.

Chapter III compares the detail level and intents of the QMM questionnaire with the demands presented by the process goals on the different levels of the P-CMM.

Chapter IV presents an analysis of conformity and discrepancies between topics addressed by the QMM and the requirements for management of processes in the P-CMM.

Chapter V presents conclusions from the analysis and recommendations for future work.

E.   BENEFITS

The Department of Defense (DoD) is the world's largest consumer of software goods and software-related services. Expenditures related to software exceed thirty billion dollar per year. The Software Technology Support Center states [STSC 00]

> Under austere budget constraints, DoD is using software as a force multiplier. Software increases the capabilities of warfighters by arming them with powerful, smart weapons and decision support tools. It gives them the flexibility to adjust to previously unknown threats. It allows them to do more with less; and it increases the effectiveness of our service men and women through information superiority.

Successful software development is mandatory to achieve these accomplishments. But military software program failures still outnumber commercial software failures [STSC 00].

This thesis will demonstrate the relevancy of the QMM-questionnaire as a measurement tool, as described above, and will show conformity and discrepancies between QMM and P-CMM. As a consequence it will show that the QMM-questionnaire is applicable as a quantitative performance measurement tool at the predictable maturity level of the P-CMM. The correlation of QMM and P-CMM will further allow program managers to use QMM results to identify deficient practices in project management. This will allow increasing the likelihood of success by changing and improving these practices, thus reducing the number of software development failures in DoD.

The ultimate goal is to develop the QMM to a metrics tool that is in full conformance and fully correlated with relevant maturity models.

II. RELATED WORK

A. QUALITY MANAGEMENT METRIC

1. Background

Development of software is regarded as successful if it

- Delivers the product on time,

- Stays within budget estimates,

- Meets user requirements [Chatzoglou 96].

To achieve success, software-development management must deal with four areas: estimation/planning, requirements, and people and risk management [Machniak 99].

a. Estimation/Planning Management

The purpose of estimation/planning management is to ensure that software is delivered on time and within budget. Empirical data have been used to identify key project attributes that affect cost and time of software development. Examples of these attributes are complexity, technical constraints, and capability and experience of personnel, and, as work progresses, the use of tools and observance of established practices. Project cost estimation models like the Constructive Cost Model (COCOMO) [Boehm 81] use these factors to estimate the size of the development effort. The impact of each attribute is calculated by using coefficients derived from empirical data, adjusted to the specifics of a given project to obtain more accurate predictions as a basis for planning.

But as to a well-known dictum by 19th-century Prussian strategist Helmuth von Moltke has it,

No plan survives first contact with the enemy

In software development, initial plans must be adjusted during development. Unforeseen difficulties in the creative process, discovery of unknowns, and changes in requirements and external constraints can and will have an impact on effort and schedule. Estimation/planning management has to

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manage resulting changes to the plan and schedule to ensure successful software development.

b.   Requirement Management

Estimation/planning management goes hand in hand with requirements management. Requirements are the initial reason for developing a software product. Customers formulate their expectations of software behavior and features through a list of requirements, and the success of a development effort is measured by how well the software conforms to stated requirements. Customers, however, do not provide specific direction as to implementation; their wishes must be interpreted by programmers as they are implemented in code. Requirement managers ensure that the initial set of requirements is of sufficient completeness and quality that misinterpretations are avoided and the product meets the customer's specifications.

The flexible nature of software often allows changes throughout the development process. Changes can result from unforeseen difficulties or from customers who are tempted to change their requirements as development progresses, based on external influences or perceived discrepancies between their own expectations and the way the requirements are actually interpreted and implemented. Requirement management has to anticipate these changes, both to control their influence and to coordinate resulting effects with estimation/planning management.

c.   People Management

Software development is a creative act performed by educated professionals. If a product is built by a single person, there is no need for people management [Machniak 99], but in professional projects there is usually more than one person engaged. With the size and complexity of today's software, the number of people involved in the typical project has also grown. These people need to be recruited, trained, organized and allocated to specific tasks to provide the human resources required for development. People managers must bear in mind that not only will the skill and performance of individual developers vary, but also the technical competence of the program manager. It is practically

impossible to staff a project with only top people. The allocation of tasks and assembly of teams must be optimized according to the available mix of personnel.

Software developers require proper leadership to sustain motivation, inspiration, and satisfaction in their creative work. Job satisfaction and individual productivity are influenced mainly by the micro work environment. Likert identifies four distinct leadership philosophies leading to distinguishable micro work environments: exploitative autocratic, benevolent autocratic, consultative and participative [Likert 67]. Leaders following a consultative or participative philosophy are seen as beneficial in creating a positive work environment. Leaders must also reinforce positive behavior and eliminate negative behavior ("reinforcement for performance") to achieve maximum productivity.

People management also addresses the communicative aspects of software development. External communication with the customer is a highly valuable means of avoiding misinterpretation of requirements. Internally, project goals, standards and specific procedures have to be mediated to achieve a common understanding among all personnel participating in the project. The goal is to establish and maintain effective internal horizontal communication between teams or among team members and vertical communication between team members and program management. Open lines of vertical and horizontal communication are crucial in achieving an encouraging working climate. It is rare to find an experienced program manager with comprehensive technical competence for every project. Open vertical communication enhances an inexperienced program manager's ability to detect upcoming difficulties in time for appropriate action, thereby reducing the risk of unwanted fallout.

d.   Risk Management

Risk management is the management aspect that identifies, mitigates, and eliminates potential problems with an aim toward minimizing harm to the overall effort. It is concerned with anticipating the outcome of future events,

and dealing with uncertainties and unforeseen consequences. The Defense Acquisition University defines risk [DAU 03] as:

> Risk is a measure of the inability to achieve overall program objectives within defined cost, schedule, and technical constraints and has two components:
> (1)   the probability of failing to achieve a particular outcome and
> (2)   the consequences/impacts of failing to achieve that outcome.

Risks arise not only from technical difficulties, but from problems in other management areas as well, because likely problems in these areas fall under the purview of risk management. As appropriate mitigation or elimination strategies are enacted, managerial responses occur in the other areas; because risk management often counters problems in one management area by taking steps in another area (e.g., effects resulting from work delays are eliminated by actions within people management), risk management is treated as a distinct management field.

2.   Quality of Management

Software-development methods have evolved over time in an attempt to enhance the prospects of project success. Numerous guides and manuals on risk management are available to provide assistance. Cost estimation methods have been refined to allow better estimates, and various tools support scheduling and planning. Despite all this, the results are far from satisfactory. More than fifty percent of software projects cost nearly ninety percent over their original estimates and the vast majority of software projects finish either over time or over budget [Osmundson 02a]. With regard to these results, cost estimation models have only limited accuracy; the intermediate COCOM model, for instance, can estimate within a factor of about two [Osmundson 02b].

One major reason for this inaccuracy results from the fact that quality of management is not taken into account by cost estimation models like COCOMO, disregarding the fact that the factor most implicated in project failure is deficient management. Poor management can increase software costs faster than any other factor and is the primary cause of failure in software development.

Implementing an input factor reflecting the quality of management into current cost and schedule estimators would increase the accuracy of these models; a metric instrument for quality management will provide such an input factor. Measuring the quality of software development management and comparing results against those achieved under management with a set of best practices will also allow identification of deficiencies and suggest corrective actions.

3.   Development of the QMM

Martin Machniak [Machniak 99] developed a metric in form of a survey to assess the quality of software-development management in a software development program. The survey is conducted as a questionnaire in four parts, divided into two sections. Each part addresses one of the software development management areas, that is, requirements, estimation/planning, people, and risk.

The questions posed are derived from research into recommended and successful practices, interviews with senior program managers and focus-group meetings. Questions in section one are pair-choice questions based on the Myers-Briggs Type Indicator (MBTI) [Briggs 93] questionnaire model. The questions require the participants to choose between two statements that present different ideas. The questions in section one detect consensus on issues and measure the strength of tendencies. Questions in section two are yes – no – not applicable (n/a) questions, a format chosen to standardize the answers for easy comparison. The questions in section two further evaluate the specific characteristics of the project and its management. The complete questionnaire contains 457 questions; each possible response is assigned a point value, which is not given to the project manager under examination.

The point totals of both sections are added together to determine the total points for each management area. The totals of each management area are then multiplied by a relative importance coefficient (IC) to receive a weighted score. The IC was determined to represent the relative importance of each of the management areas and their influence on the overall success of a software development project, based on actual experience. The weighted scores of the

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four management areas are than added together to yield the Quality Management Metric (QMM) score. The QMM equation is as follows:

QMM = 1.86 PM + 0.92 RqM + 0.67 EPM + 0.55 RkM

PM is the people-management metric. It is assigned the highest importance coefficient, according to its importance in software-development. RqM is the requirements-management metric; EPM is the estimation/planning-management metric and RkM stands for the risk-management metric.

Martin Machniak performed a test and an initial validation of the QMM with three software development programs [Machniak 99]. Mary Grossmann continued this work and performed an informal verification and validation of the metric with another ten software development programs [Grossmann 00]. Both studies yielded positive correlation between the results of the QMM and the overall success score. Mary Grossmann states consequently [Grossmann 00]:

> The results of applying the QMM can be used to characterize the quality of software management and can serve as a template to improve software management performance.

4.   Questions of the QMM

a.   Estimation/Planning Management

Planning is one of the core tasks of management. It is based on estimation of three major program measures: products, processes, and resources [Pressman 93]. Product measures address the volume of products produced. Process measures quantify behavior, development and problem-solving strategies, and execution of the process used to develop the products. Event counts (i.e., number of requirement changes) and time measures are included in process measures. Resource measures address the resources (e.g., labor hours, tools etc.) and their proper allocation to tasks.

Accurate initial estimation of these measures will allow realistic planning of schedules and costs. As changes occur during the program, the program manager tracks product, process, and resource measures and makes necessary adjustments to the planning. The questions of the estimation/planning

part of the QMM questionnaire target the quality of estimation and planning. They determine whether initial and follow-up estimation and planning is conducted and documented, and whether this occurs using accepted software management methods and practices.

b. Requirement Management

One mark of successful software development is that the product meets customer expectations. The program manager has to establish procedures to define these expectations and to translate them into requirements that are complete, consistent, readable, unambiguous and testable. Test strategies and procedures have to be installed to verify conformity of the product with the extracted requirements. It is imperative to involve all stakeholders in the process of requirement extraction, as the requirements serve both as the source of feature implementation and (usually) as the contractual basis for development. Agreeing carefully on features is a means of identifying and communicating constraints on both sides and clarifying implementation priorities.

Despite the flexible nature of software, requirement changes can have an enormous impact on schedule and costs of software development, especially if they occur late in the development process [Humphrey 95]. Procedures for change control and management should be an integral part of requirement management.

The questions of the QMM questionnaire evaluate the program on established procedures in requirements management. The areas addressed are requirement extraction, testability, and change management.

c. People Management

Because people management is the most important part of software-development management, it is assigned the highest importance coefficient (IC) value in the QMM equation. How management recruits, organizes and treats human resources is crucial to the success of a development program [Pressman 93].

The QMM questionnaire evaluates the three main areas of people management: handling of human resources, communication, and leadership. The hierarchy of factors and allocated sub factors is shown in Figure 2.
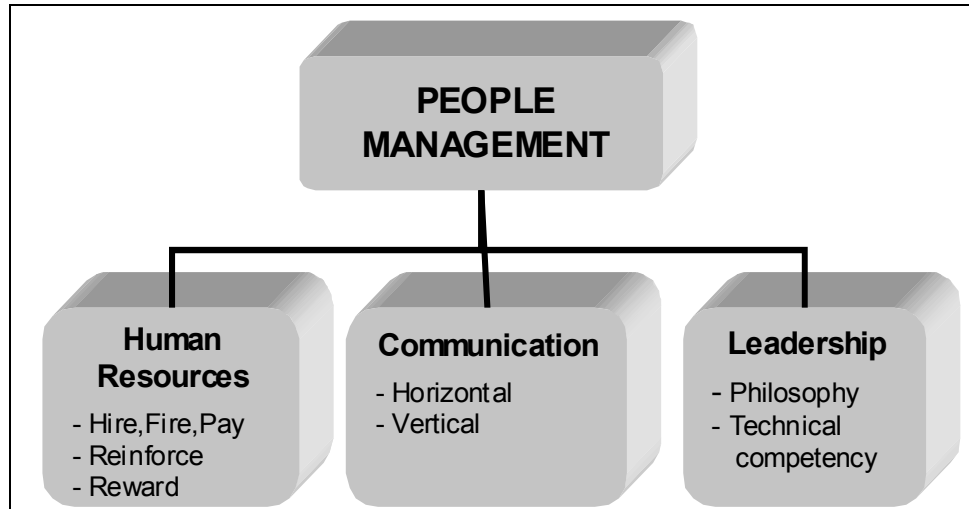
Figure 2.   People Management Areas (from [Machniak 99]

The questions are designed to evaluate the program manager's ability to:

- Recruit, train and allocate human resources appropriately, including reinforcement and reward

- Implement and sustain structures to facilitate vertical and horizontal communication, both within and without the program under evaluation

- Provide leadership to the program and associated personnel, including evaluation of skills and competency of the program manager

The questions do not attempt to type the program manager. However, as leadership following a consultative or participative philosophy is seen as beneficial to a positive work environment, scoring rewards commensurate behavior.

d.   Risk Management

Risk is inherent to any development program. Risky areas in software development include software, hardware, technology, cost, schedule, and people.   Risk management is the management aspect that identifies,

mitigates and eliminates potential problems to minimize induced negative effects on program success, and consists of two steps, risk assessment and control. Risk assessment is the task of identifying, analyzing and prioritizing risks as an ongoing task as changes occur. Risk control involves risk management, resolution and monitoring [Osmundson 02b].

The QMM examines the quality of risk management by looking at the components of risk management, assessment and control. The questions evaluate whether the program manager has set up strategies, structures, and procedures to thoroughly implement these components in the program.

B.   PEOPLE CAPABILITY MATURITY MODEL

1.   Background

New methodologies in the quest for consistent software-project success have been devised over the years, but none has proven adequate to the task. Nevertheless, it is well demonstrated that deficient management is a fundamental problem and the factor most likely to spell project failure [OUSDA 87].

In 1986, in response to a request by the U.S. government, the Software Engineering Institute (SEI) started developing a model of a process maturity framework to help software developers improve their processes. The SW-CMM categorizes five levels of maturity of development processes and describes associated abilities and management and development practices. SW-CMM provides organizations with guidance on process assessments, software-capability evaluations, and process-improvement steps. After the release of an initial version in 1991, a reviewed version of the Capability Maturity Model for Software (SW-CMM v.1.1) was released in 1993 [Paulk 93]. Since then, this model has been widely accepted and adopted in the commercial software-development industry.

As previously noted, software development is a process highly dependent on the quality of the individuals involved. Dave Ulrich, named by the magazine

Business Week [BW 01] as the world's top educator in human resources, states [Ulrich 97]:

> Successful firms will be those most adept at attracting, developing and retaining individuals with the skills, perspectives, and experience necessary to drive a global business.

A shortage of experienced software professionals in the 1990s caused problems for organizations attempting to build and retain a skilled workforce. Personnel shortfalls lead to equal project risks. Positive experience with the SW-CMM led to requests for a derived model for improving workforce practices. The first version of the People Capability Maturity Model (P-CMM) was developed and released 1995 in response to these requests. Version 2.0 [Curtis 01] was released in 2001, adding enhancements learned from five years of implementation experience.

2. Overview

Capability maturity models describe the span of implementation of processes and practices within an organization. Processes and practices are allocated to different maturity levels, which represent different levels of organizational capability. The existing capability maturity models describe five levels of maturity. The maturity levels of the P-CMM range from the initial level providing minimal organizational capabilities, up to an optimized level with maximum organizational capabilities. Figure 3. shows the five maturity levels of the P-CMM.
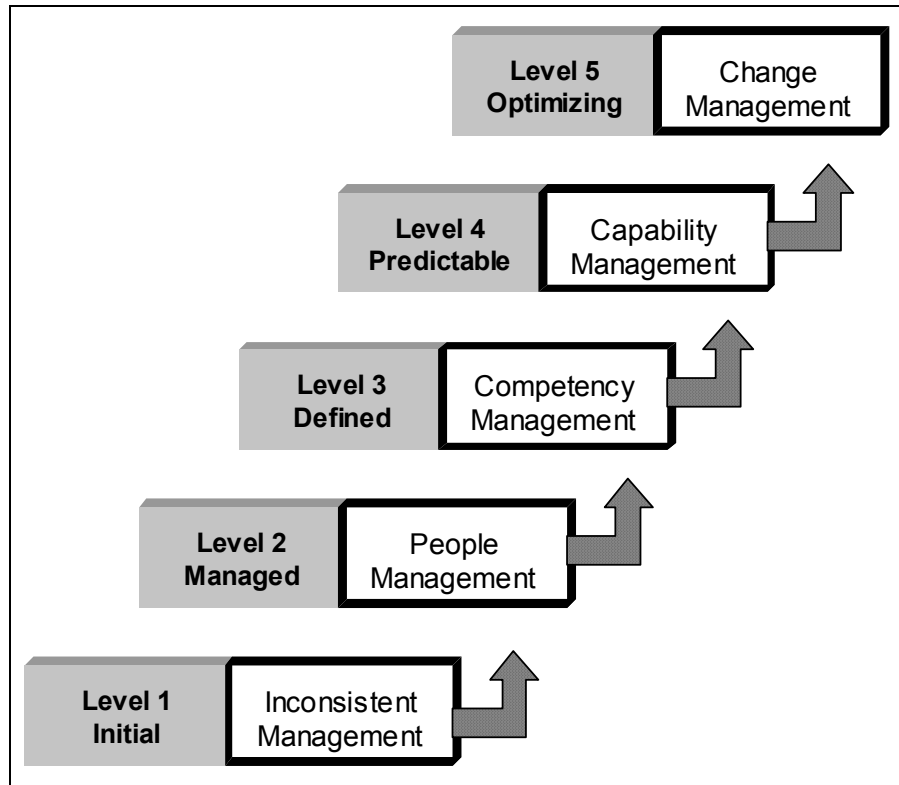
Figure 3.   Maturity Levels of the People CMM (from: [Curtis 01])

Each maturity level contains several process areas. Practices are allocated to a maturity level to achieve process-area goals. Figure 4. shows the architecture of the P-CMM. Notably the implementation of practices is not a component of the P-CMM.

Figure 4.   Architecture of the People CMM (from: [Curtis 01])

3.   Maturity levels of the P-CMM

a.   Level 1: Initial

The initial level is the lowest in the people-capability maturity model. An organization at the initial level will exhibit the least organizational capabilities, as no specific process areas are developed. Management of the workforce and workforce practices are often *ad hoc* and inconsistent. Organizations at the initial level are characterized by

- Inconsistency in practices
- Displacement of responsibility
- Ritualistic practices, and
- Emotional detachment among the workforce.

b.   Level 2: Managed

Processes at the second level focus on establishing a foundation of basic workforce practices at the unit level. The goals are to eliminate work-environment problems that hamper work at the unit level and to establish a

foundation for continuous development and improvement of workforce capabilities. Repeatable basic practices for managing the workforce are established and managers are assigned to accept responsibility for performance and personnel development in their units.

Performance management is introduced on the managed level. Its purpose is to establish objectives against which unit and individual performance can be compared.

Process areas at the managed level are

- Staffing
- Communication and coordination,
- Work environment
- Performance management
- Training and development
- Compensation

c. Level 3: Defined

Basic workforce practices on unit level have been established on maturity level two. On level three, organizations identify process abilities, knowledge and skills that are required to perform business activities. Competencies are fostered, matured, and aligned corporation-wide. The capability to manage a workforce as a strategic asset is developed.

A participatory culture is established to ensure the flow of information within the organization and to incorporate the knowledge of individuals into decision-making.

Process areas at the defined level are

- Competency analysis
- Workforce planning
- Competency development
- Career development
- Competency-based practices
- Workgroup development

- Participatory Culture

d. Level 4: Predictable

Organizations at maturity-level four quantify and manage the capability of their workforce and their competency-based processes. The quantification allows for the evaluation of trends in the capability of the organization and its elements. Organizations execute quantitative performance management to predict and manage the capability of competency-based processes. Performance data are collected and analyzed and these evaluated performance data are used as process-performance baselines in planning processes. Corrective actions are taken when actual performance differs from objectives and predictions.

"In an immature organization, there is no objective basis for judging product quality or for solving product or process problems. Therefore, product quality is difficult to predict" [SW-CMM]

Another key idea at the predictable level is the building of empowered teams that are able to manage their own work processes. The idea is to build teams so that the different skills and experience of individuals complement each other.

Process areas at the defined level are
- Competency integration
- Empowered workgroups
- Competency-based assets
- Quantitative performance management
- Organizational capability management
- Mentoring

e. Level 5: Optimizing

Process areas are fully developed at the optimizing level. Organizations are continually applying methods for developing competence on the individual, unit, and organizational level and try to further improve their methods. The effectiveness of workforce practices is analyzed and new technologies and practices are evaluated. Successful elements are implemented for further use.

Process areas at the defined level are

- Continuous capability improvement
- Organizational performance alignment
- Continuous workforce innovation

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III. COMPARISON OF QMM AND P-CMM

A. COMPARABLE LEVEL OF DETAIL

1. QMM

A management survey instrument in form of a questionnaire has to be manageable, usable and applicable for a broad range of projects. This limits the number of questions and the level of detail a questionnaire can contain. The QMM questionnaire overall contains 457 questions, resulting in a reasonable average survey-completion time of 45 minutes. One hundred and eighteen questions, divided in two sections, address people management. This number is sufficient to evaluate relevant management ideas but restricts the level of detail at which practices to implement those ideas can be evaluated.

The questions in section one that pertain to people management are designed to detect consensus on issues and ideas, but not to address specific implementations of these ideas. For instance, one question asks whether management leads problem solving or whether management merely facilitates, letting the team leader act. Another question address the participatory culture by asking whether the relationship between the team and manager is of an adult/adult or parent/child type. Both cases evaluate to what degree the specific idea or goal under investigation is strived for, but do not examine the specific implementation.

In section two, questions are yes-no-n/a queries that address goals of processes and practices, but, again, do not address implementation. For example, whether the program manager facilitates communication during integration is asked, but as implementation will depend on the characteristics of a specific project or organization, it is not covered.

Thus, the QMM questionnaire does not question every implementation detail but remains at a reasonable abstraction level and examines whether, in a given project, good management goals are pursued and implemented. This

approach allows projects to choose different implementations of goals and practices without negative impact on the QMM score.

The project manager will often be limited by external constraints in his goals and practices. The n/a selection in section two of each management area allows the test to consider constraints. The questions are designed so that the QMM score is unaffected by constraints.

2. P-CMM

Starting with the second level, three-to-five process areas are associated with each maturity level, for a total of twenty-two. Process areas represent a set of interrelated practices that together enable an organization or unit to achieve the capabilities related to the specific maturity level. For each process area, goals are described that an organization or unit that describe what must be implemented to satisfy the purpose of the process area (see Figure 4 for a description of the P-CMM architecture).

In a next step a set of practices is described for each process area. The practices contribute to the goals of the process area. A mapping of practices to goals is conducted in annex D of [Curtis 01]. However, the P-CMM states [Curtis 01]:

> These practices have been selected for inclusion because they contribute to satisfying process area goals. However, they are neither an exclusive or exhaustive list of practices an organization might implement in pursuing the goals of a process area.

> And furthermore [Curtis 01]:

> Similarly, when assessing or evaluating alternative ways to implement a process area, the goals can be used to determine if the alternative practices satisfy the intent of the process area.

This allows organizations to implement practices differing from those named in the P-CMM as long as these practices are able to pursue the goals of the respective process area. In conclusion, process goals associated with the process areas are reasonable candidates in the P-CMM for a comparison of P-CMM compliance of the QMM.

The P-CMM addresses the development of the capabilities of an organization as a whole. The listed process areas deal with four areas of concern:

- Developing individual capability
- Building workgroups and culture
- Motivating and managing performance
- Shaping the workforce

Thus the process areas and derived goals of the P-CMM deal with processes and practices on the individual, on the unit and on the organizational level. A survey of the quality of management in a specific project has to take into account practices influencing the individual person or the specific unit and under survey. Practices targeting the organization or its capabilities as a whole, e.g. whether an organization tracks its capabilities of its workforce competencies, are neither the subject of management activities of a project management nor do they have direct impact on the success of a project. For this reason the process goals of the P-CMM are examined to determine the goals relevant for a comparison with the QMM.

B. PROCESS GOALS OF P-CMM

1. General

Process areas organize interrelated practices and constitute major organizational processes. They are described by their purpose and associated goals. Based on the descriptions in [Curtis 01], following these process goals are examined to determine which process goals are relevant for a comparison with the QMM. A process goal is relevant for a comparison if it either addresses practices and activities performed by the project management or if it has direct influence on the activities and individuals in a project.

2. Process Areas at Level 2

a. Staffing

Purpose / goals [Curtis 01]:

The purpose of staffing is to establish a formal process by which committed work is matched to unit resources and qualified individuals are recruited, selected, and transitioned into assignments.

- Goal 2.a.1: Individuals or workgroups in each unit are involved in making commitments that balance the unit's workload with approved staffing.

- Goal 2.a.2: Candidates are recruited for open positions

- Goal 2.a.3: Staffing decisions and work assignments are based on an assessment of work qualifications and other valid criteria

- Goal 2.a.4: Individuals are transitioned into and out of positions in an orderly way.

- Goal 2.a.5: Staffing practices are institutionalized to ensure they are performed as managed processes.

Software development is a creative act performed by educated professionals. Software projects need to be staffed adequately to be able to perform software development. While as a practical matter it is impossible to staff a project with only top people, allocation of tasks and team assembly must be optimized according to the available personnel. Therefore, staffing with all listed goals (2.a.1 - 2.a.5) is a process area relevant for project management and a comparison with the QMM.

b. Communication and Coordination

Purpose / goals [Curtis 01]:

The purpose of Communication and Coordination is to establish timely communication across the organization and to ensure that the workforce has the skills to share information and coordinate their activities efficiently.

- Goal 2.b.1: Information is shared across the organization

- Goal 2.b.2: Individuals or groups are able to raise concerns and have them addressed by management

- Goal 2.b.3: Individuals and workgroups coordinate their activities to accomplish committed work

- Goal 2.b.4: Communication and Coordination practices are institutionalized to ensure they are performed as managed processes

Communication is a key in software development; it is crucial to coordinate the work of developers fulfilling individual tasks and to notify the management about problems and deviations from plans. Communication is also necessary between developer and customer to avoid misinterpretation of product requirements. Communication and coordination with all associated goals (2.b.1 – 2.b.4) is a process area relevant for project management and a comparison with the QMM.

c.   Work Environment

Purpose / goals [Curtis 01]:

The purpose of Work Environment is to establish and maintain physical working conditions and to provide resources that allow individuals and workgroups to perform their tasks efficiently and without unnecessary distractions.

- Goal 2.c.1: The physical environment and resources needed by the workforce to perform their assignments are made available.

- Goal 2.c.2: Distractions in the work environment are minimized.

- Goal 2.c.3: Work Environment practices are institutionalized to ensure they are performed as managed processes.

A proper work environment is required to be able to perform development activities. One might argue that the organization is responsible for providing required resources to the project as a whole. Nevertheless, it is the responsibility of the program manager to ensure that within his project the environment and resources required to perform the work are available. It is also his responsibility to identify and address factors that degrade effectiveness. The process area of work environment, with all associated goals (2.c.1 – 2.c.3), is relevant for project management and a comparison with the QMM.

d.   Performance Management

Purpose / goals [Curtis 01]

The purpose of Performance Management is to establish objectives related to committed work against which unit and individual performance can be measured, to discuss performance against these objectives, and to continuously enhance performance.

- Goal 2.d.1: Unit and individual performance objectives related to committed work are documented.

- Goal 2.d.2: The performance of committed work is regularly discussed to identify actions that can improve it.

- Goal 2.d.3: Performance problems are managed.

- Goal 2.d.4: Outstanding performance is recognized or rewarded.

- Goal 2.d.5: Performance Management practices are institutionalized to ensure they are performed as managed processes.

Software has to be delivered on time and within budget. Related planning and scheduling is based on expectations of work performed by units and individuals, i.e., performance objectives. Leaders must reinforce positive behavior and eliminate negative behavior ("reinforcement for performance") to achieve maximum productivity. Performance management, with all associated goals (2.d.1 – 2.d.5), is a process area relevant for project management and a comparison with the QMM.

e. *Training and development*

Purpose / goals [Curtis 01]:

The purpose of Training and Development is to ensure that all individuals have the skills required to perform their assignments and are provided relevant development opportunities.

- Goal 2.e.1: Individuals receive timely training that is needed to perform their assignments in accordance with the unit's training plan

- Goal 2.e.2: Individuals capable of performing their assignments pursue development opportunities that support their development objectives

- Goal 2.e.3: Training and Development practices are institutionalized to ensure they are performed as managed processes.

Training is a means that project management can use to equip workers to perform their assignments. The training aspect with related goals (2.e.1, 2.e.3) is relevant for project management and a comparison with the QMM.

The project mangers will identify individuals capable of performing assignments as part of performance-management processes (III.B.2.d). A project's internal management activities are covered by performance management (III.B.2.d) and compensation processes (III.B.2.f). Information about outstanding performance may also be passed to other parts of the organization as part of their effort to give recognition as appropriate. Providing opportunities to pursue advanced development, however, will exceed the scope of a project and its management, as it is not justified by project needs. Goal 2.e.2 therefore is not a candidate for comparison with the QMM.

f. Compensation

Purpose / goals [Curtis 01]:

The purpose of Compensation is to provide all individuals with remuneration and benefits based on their contribution and value to the organization.

- Goal 2.f.1: Compensation strategies and activities are planned, executed, and communicated

- Goal 2.f.2: Compensation is equitable relative to skill, qualifications and performance

- Goal 2.f.3: Adjustments in compensation are made based on defined criteria

- Goal 2.f.4: Compensation practices are institutionalized to ensure they are performed as managed processes.

A compensation strategy is developed on the organizational level. Though compensation is interwoven with staffing (III.B.1.a) which is a responsibility of project management, compensation is normally determined by organizational regulations, e.g. in government [Machniak 99]. The program manager is only able to arrange an equitable compensation relative to skill, qualifications and performance within the limits of these regulations. Compensation with its associated goals (2.f.1 – 2.f.4) as a process area that addresses actions on the organizational level therefore is not a candidate for a comparison with the QMM.

3. Process Areas at Level 3

a. Competency Analysis

Purpose / goals [Curtis 01]:

The purpose of Competency Analysis is to identify the knowledge, skills, and process abilities required to perform the organization's business activities so that they may be developed and used as a basis for workforce practices.

- Goal 3.a.1: The workforce competencies required to perform the organization's business activities are defined and updated
- Goal 3.a.2: The work processes used within each workforce competency are established and maintained
- Goal 3.a.3: The organization tracks its capability in each of its workforce competencies
- Goal 3.a.4: Competency Analysis practices are institutionalized to ensure they are performed as defined organizational processes.

The ability to perform software development as a business requires certain workforce competencies. These competencies need to be identified and defined; underlying competency-based processes need to be established. While one might argue that this task is primarily important on the organizational level, it also has relevancy on the project management level.

Even if information on competencies is delivered and processes are established at the organizational level, project specifics still may require deviations. The project management has to identify required competencies specific for its software development project as a basis for recruiting and training. Competency-based processes need to be established on the project level and tailored to specific project needs. Tracking of project-team capabilities is part of project control and supervision. Competency analysis—with its scope including project specific competencies and processes—with all associated goals (3.a.1 – 3.a.4) is a process area relevant for project management and a comparison with the QMM.

b.   Workforce Planning

Purpose / goals [Curtis 01]:

The purpose of Workforce Planning is to coordinate workforce activities with current and future business needs at both the organizational and unit levels.

- Goal 3.b.1: Measurable objectives for capability in each of the organizations workforce competencies are defined

- Goal 3.b.2: The organization plans for the workforce competencies needed to perform its current and future business activities

- Goal 3.b.3: Units perform workforce activities to satisfy current and strategic competency needs

- Goal 3.b.4: Workforce Planning practices are institutionalized to ensure they are performed as defined organizational processes.

On the organizational level, workforce activities are tied to an organization's business strategy and objectives as a basis for strategic planning. Project management will not conduct activities on this level. Goals 3.b.1 and 3.b.2 therefore are not candidates for a comparison with the QMM.

Management has to perform planning activities to satisfy current and future competency needs. Workforce activities at the unit level—i.e., the level of an individual project—are explicitly addressed by goal 3.b.3. Workforce planning with its associated goals 3.b.3 and 3.b.4 is a process area that is partly relevant for project management and comparison with the QMM.

c. *Competency Development*

Purpose / goals [Curtis 01]:

The purpose of Competency Development is to constantly enhance the capability of the workforce to perform their assigned tasks and responsibilities.

- Goal 3.c.1: The organization provides opportunities for individuals to develop their capabilities in its workforce competencies

- Goal 3.c.2: Individuals develop their knowledge, skills, and process abilities in the organization's workforce competencies

- Goal 3.c.3: The organization uses the capabilities of its workforce as resources for developing the workforce competencies of others.

- Goal 3.c.4: Competency Development practices are institutionalized to ensure they are performed as defined organizational processes.

Competency development activities are intended to serve business objectives. They increase the individuals' ability to work in their units and are meant to support their development objectives. Projects will benefit from these

processes and may even participate in related activities. Competency development, however, targets the business objectives of the organization, while project needs are addressed by other activities (e.g., training and development). The process area competency development and its associated goals therefore is not a candidate for a comparison with the QMM.

d. Career Development

Purpose / goals [Curtis 01]:

The purpose of Career Development is to ensure that individuals are provided opportunities to develop workforce competencies that enable them to achieve career objectives.

- Goal 3.d.1: The organization offers career opportunities that provide growth in its workforce competencies

- Goal 3.d.2: Individuals pursue career opportunities that increase the value of their knowledge, skills, and process abilities to the organization.

- Goal 3.d.3: Career Development practices are institutionalized to ensure they are performed as defined organizational processes.

Career Development may target overarching career opportunities and objectives beyond the level of project management. The project management however is directly involved as career development depends on underlying activities in areas like performance management and competency development. Career Development activities of the program management also contribute to motivation and reinforcement for performance. The program manager has to be active in Career Development practices that require direct interaction with the individual like capability assessment and counseling, while offering of career opportunities and institutionalizing career development practices reside on the organizational level. Goal 3.d.2 therefore is a goal from the process area Career Development that is a candidate for a comparison with the QMM, while goals 3.d.1 and 3.d.3 are not candidates.

e. Competency-Based Practices

Purpose / goals [Curtis 01]:

The purpose of Competency-Based Practices is to ensure that all workforce practices are based in part on developing the competencies of the workforce.

- Goal 3.e.1: Workforce practices are focused on increasing the organization's capability in its workforce competencies

- Goal 3.e.2: Workforce activities within units encourage and support individuals and workgroups in developing and applying the organization's workforce competencies.

- Goal 3.e.3: Compensation strategies and recognition and reward practices are designed to encourage development and application of the organization's workforce competencies

- Goal 3.e.4: Competency-based practices are institutionalized to ensure they are performed as defined organizational processes.

In the process area of competency-based practices, processes and practices are adjusted and aligned throughout the organization to support its focus on developing workforce skills and to meet strategic goals. Goal 3.e.2 addresses the impact on project management, as practices at the unit level must adjust to meet organizational strategic plans and objectives. Strategic plans and objectives will have an impact on project management in the form of directives or constraints which must be dealt with. The resulting activities, however, are following overarching purposes and not related to a specific project. The process area competency-based practices and its associated goals therefore are not candidates for a comparison with the QMM.

f.   *Workgroup Development*

Purpose / goals [Curtis 01]:

The purpose of Workgroup Development is to organize work around competency-based process abilities.

- Goal 3.f.1: Workgroups are established to optimize the performance of interdependent work.

- Goal 3.f.2: Workgroups tailor defined processes and roles for use in planning and performing their work.

- Goal 3.f.3: Workgroup staffing activities focus on the assignment, development, and future deployment of the organization's workforce competencies

- Goal 3.f.4: Workgroup performance is managed against documented objectives for committed work.

- Goal 3.f.5: Workgroup Development practices are institutionalized to ensure they are performed as defined organizational processes.

For a product built by a single person, there is no need for people management. With the size and complexity of today's software, however, the number of people involved in the typical project has mushroomed. Software development as a business activity employing specific competency-based processes is performed by workgroups consisting of teams or individuals performing interdependent work. Workgroup development is a fundamental task of project management. The process area of workgroup development, with associated goals (3.f.1 – 3.f.5), is a process area relevant for project management.

g.   *Participatory Culture*

Purpose / goals [Curtis 01]:

The purpose of a Participatory Culture allows the organization to exploit the full capability of the workforce for making decisions that affect the performance of business activities.

- Goal 3.g.1: Information about business activities and results is communicated throughout the organization

- Goal 3.g.2: Decisions are delegated to an appropriate level of the organization

- Goal 3.g.3: Individuals and workgroups participate in structured decision-making processes

- Goal 3.g.4: Participatory Culture practices are institutionalized to ensure they are performed as defined organizational processes.

The kind of leadership philosophy a leader demonstrates determines the micro work environment. Providing leadership is one of the fundamental tasks of a program manager. The process area of participatory culture, with its associated goals (3.g.1 – 3.g.4), is a relevant for project management and a comparison with the QMM.

4.   Process Areas at Level 4

a.   *Competency Integration*

Purpose / goals [Curtis 01]:

The purpose of Competency Integration is to improve the efficiency and agility of interdependent work by integrating the process abilities of different workforce competencies.

- Goal 4.a.1: The competency-based processes employed by different workforce competencies are integrated to improve the efficiency of interdependent work

- Goal 4.a.2: Integrated competency-based processes are used in performing work that involves dependencies among several workforce competencies

- Goal 4.a.3: Workforce practices are designed to support multi-disciplinary work

- Goal 4.a.4: Competency Integration practices are institutionalized to ensure they are performed as defined organizational processes.

Software development constitutes a specific distinguishable workforce competency. This process area, however, targets integration and coordination of separate workforce competencies, like market research, sales, and software development. Respective dependencies at the project management level are already covered in process areas such as communication and coordination. The process area competency-based practices and its associated goals are not candidates for a comparison with the QMM.

b. Empowered Workgroups

Purpose / goals [Curtis 01]:

The purpose of Empowered Workgroups is to invest workgroups with the responsibility and authority for determining how to conduct their business activities most effectively.

- Goal 4.b.1: Empowered workgroups are delegated responsibility and authority over their work processes.

- Goal 4.b.2: The organization's workforce practices and activities encourage and support the development and performance of empowered workgroups.

- Goal 4.b.3: Empowered workgroups perform selected workforce practices internally

- Goal 4.b.4: Empowered Workgroup practices are institutionalized to ensure they are performed as defined organizational processes.

An empowered workgroup describes a workgroup, unit, or unit component that is granted responsibility and authority for a whole work process [Wellins 91]. Empowered workgroups are able to act independently within the constraints of the overarching element. While the whole software-development team constitutes an empowered workgroup, the size and complexity of today's software development efforts requires a breakdown of work efforts. This encourages building of responsible empowered workgroups within the project team. The process area of participatory culture, with its associated goals (4.b.1 – 4.b.4) is a process area relevant for project management and comparison with the QMM.

c.   *Competency-Based Assets*

Purpose / goals [Curtis 01]:

The purpose of Competency-Based Assets is to capture the knowledge, experience, and artifacts developed in performing competency-based processes for use in enhancing capability and performance.

- Goal 4.c.1: The knowledge, experience, and artifacts resulting from performing competency-based processes are developed into competency-based assets

- Goal 4.c.2: Competency-based assets are deployed and used.

- Goal 4.c.3: Workforce practices and activities encourage and support the development and use of competency-based assets

- Goal 4.c.4: Competency-based assets activities are institutionalized to ensure they are performed as defined organizational processes.

Competency-based assets describe assets developed and provided at the organizational level for widespread use. These assets capture the knowledge, experience, or artifacts of competency-based processes and make them available. Software development projects will benefit from the existence of such assets, but for the scope of management such benefits are already dealt with as input in competency-analysis processes. Projects will also contribute to the development of competency-based assets. Associated activities, however, are not part of the software-development effort. The process area competency-

based assets and its associated goals are not candidates, therefore, for a comparison with the QMM.

d. *Quantitative Performance Management*

Purpose / goals [Curtis 01]:

The purpose of Quantitative Performance Management is to predict and manage the capability of competency-based processes for achieving measurable performance objectives.

- Goal 4.d.1: Measurable performance objectives are established for competency-based processes that most contribute to achieving performance objectives

- Goal 4.d.2: The performance of competency-based processes is managed quantitatively

- Goal 4.d.3: Quantitative Performance Management practices are institutionalized to ensure they are performed as defined organizational processes

Predicting capabilities and managing performance form the basis of any scheduling and planning. Quantitative performance management is a necessary and fundamental task of project management. The process area quantitative performance management with all associated goals (4.d.1 – 4.d.3), is therefore a process area relevant for project management and a comparison with the QMM.

e. *Organizational Capability Management*

Purpose / goals [Curtis 01]:

The purpose of Organizational Capability Management is to quantify and manage the capability of the workforce and of the critical competency-based processes they perform.

- Goal 4.e.1: Progress in developing the capability of critical workforce competencies is managed quantitatively

- Goal 4.e.2: The impact of workforce practices and activities on progress in developing the capability of critical workforce competencies is evaluated and managed quantitatively

- Goal 4.e.3: The capabilities of competency-based processes in critical workforce competencies are established and managed quantitatively

- Goal 4.e.4: The impact of workforce practices and activities on the capabilities of competency-based processes in critical workforce competencies is evaluated and managed quantitatively

- Goal 4.e.5: Organizational Capability Management practices are institutionalized to ensure they are performed as defined organizational processes.

Organizational-capability management targets the capabilities of the workforce as whole. Workforce competencies most critical for an organization's business strategy and objectives are identified and their availability evaluated. Because the focus of these activities is beyond the level of project management, organizational-capability management and its associated goals are not candidates for a comparison with the QMM.

f.   Mentoring

Purpose / goals [Curtis 01]:

The purpose of Mentoring is to transfer the lessons of greater experience in a workforce competency to improve the capability of other individuals or workgroups.

- Goal 4.f.1: Mentoring programs are established and maintained to accomplish defined objectives

- Goal 4.f.2: Mentors provide guidance and support to individuals or workgroups

- Goal 4.f.3: Mentoring practices are institutionalized to ensure they are performed as defined organizational processes.

Mentoring addresses programs and activities at the organizational level. Projects benefit where mentoring and coaching are provided in an organized and structured form. Such activities at the project management level however are initiated as part of activities in the process area of training. The process area of mentoring and its associated goals are not candidates for a comparison with the QMM.

5.   Process Areas at Level 5

a.   Continuous Capability Improvement

Purpose / goals [Curtis 01]:

The purpose of Continuous Capability Improvement is to provide a foundation for individuals and workgroups to continuously

improve their capability for performing competency-based processes.

- Goal 5.a.1: The organization establishes and maintains mechanisms for supporting continuous improvement of its competency-based processes.

- Goal 5.a.2: Individuals continuously improve the capability of their personal work processes.

- Goal 5.a.3: Workgroups continuously improve the capability of their workgroup's operating processes.

- Goal 5.a.4: The capabilities of competency-based processes are continuously improved.

- Goal 5.a.5: Continuous Capability Improvement practices are institutionalized to ensure they are performed as defined organizational processes.

The process area of continuous capability improvement addresses improvement at the organizational, unitary, and workgroup levels. Improvements on the organizational level (i.e., Goal 5.a.1) are beyond the scope of project management. Project management supports improvements for individuals (i.e., Goal 5.a.2) with activities from areas such as performance management, but the process itself is not part of project management. Project managers, however, should strive to improve of the capability of operating and competency processes and execute related practices. Continuous capability improvement, with its associated goals (5.a.3, 5.a.4 and 5.b.5), is a process area partly relevant to project management and comparison with the QMM.

b. *Organizational Performance Alignment*

Purpose / goals [Curtis 01]:

The purpose of Organizational Performance Alignment is to enhance the alignment of performance results across individuals, workgroups and units with organizational performance and business objectives.

- Goal 5.b.1: The alignment of performance among individuals, workgroups, units and the organization is continuously improved.

- Goal 5.b.2: The impact of workforce practices and activities on aligning individual, workgroup, unit, and organizational performance is continuously improved.

- Goal 5.b.3: Organizational Performance Alignment practices are institutionalized to ensure they are performed as defined organizational processes

Quantitative performance management delivers information about the performance of individuals and units. Reinforcement for good performance is a means of achieving maximum productivity, which includes aligning performance at the highest possible level. Organizational performance alignment, with associated goals (5.b.1 – 5.b.3) is therefore relevant for project management and comparison with the QMM.

c. *Continuous Workforce Innovation*

Purpose / goals [Curtis 01]:

The purpose of Continuous Workforce Innovation is to identify and evaluate improved or innovative workforce practices and technologies, and implement the most promising ones throughout the organization.

- Goal 5.c.1: The organization establishes and maintains mechanisms for supporting continuous improvement of its workforce practices and technologies.

- Goal 5.c.2: Innovative or improved workforce practices and technologies are identified and evaluated.

- Goal 5.c.3: Innovative or improved workforce practices and technologies are deployed using orderly procedures

- Goal 5.c.4: Continuous Workforce Innovation practices are institutionalized to ensure they are performed as defined organizational practices.

Software projects can take advantage of innovative and improved practices and technologies. New benefits, however, have to be considered against the risks and costs involved in changing to new technologies and practices. Goal 5.c.1 provides a framework that empowers workgroups and project managers to employ improvements. Goals 5.c.2 to 5.c.4 describe the practices related to improvement activities conducted by management. The process area continuous workforce innovation, with its associated goals (5.c.2, 5.c.3 and 5.c.4) is relevant for project management and comparison with the QMM.

IV.   ANALYSIS OF COMPLIANCE OF QMM WITH P-CMM

A.   GENERAL

Relevant for an evaluation of the quality of management of a software development are process goals that target activities on the unit or workgroup level. Process goals targeting the organizational level may require inputs or corresponding activities by project management. These activities however are not related to a specific software development project and cannot be incorporated in measuring the quality of software development project management.

The P-CMM lists twenty-two process areas on maturity levels two to five that contribute to the capabilities of the workforce of an organization. Each process area contains three to five goals stating the objective of the process area, adding up to a total number of ninety process goals. Chapter III identified fifty-one process goals from fifteen process areas that target practices and activities that not only have to be performed by project management but also are affect project's success. The QMM has to address these project goals to be fully conformant with the P-CMM.

Note that following the P-CMM does not involve ranking of process goals beside the allocation of processes to different maturity levels. The P-CMM also does not provide information about the impact the different processes have on the success of a software development project. It describes all processes with a uniform level of detail. The representation of processes - given by the number of questions and the level of detail - in the QMM however depends on the significance of the specific process for the project outcome. P-CMM processes therefore are represented in the QMM differently depending on the importance of the specific process for the project outcome.

In each process area, there is one process goal that addresses whether the processes are institutionalized. This is done uniformly for all process areas to ensure that processes are performed as managed or defined organizational

processes. To fulfill these process goals, organizations are requested to establish and maintain documented policies for the respective activities, to assign responsibility and authority for performing activities and to review implementation. The implementation of a program manager role implies assignment of responsibility and authority. Policy establishment and review activities on the organizational level are not part of the project manager's responsibilities and cannot be used to determine his quality of management. Institutionalization in the level of a unit is seen when practices are performed in a managed way and consistently.

The QMM questions are portioned into the four management areas: people management, estimation/planning management, risk management, and requirements management. The P-CMM, as a self-contained model, also contains aspects that the QMM allocates to other management areas. The respective questions of other management areas in the QMM have been considered in the comparison to the P-CMM where applicable.

B.   COMPARISON MATRICES

Appendix A contains the QMM questionnaire from [Machniak 99].

Appendix B contains a complete comparison matrix. The matrix incorporates the questions of both sections of the people management part of the QMM. Questions of other management parts are added where applicable. Questions are numbered for better identification in the different evaluated matrices.

Appendix C contains the evaluated comparison matrices. For each process area the process goals are listed, followed by an evaluated comparison matrix for this process area. The evaluated comparison matrix indicates association of questions to process goals. Where the wording of a question was not sufficient to identify underlying concepts, the concept descriptions from [Machniak 99] were consulted. For further characterization of process goals, the related example practices and descriptions from [Curtis 01] were consulted.

QMM questions not related to the goals of the specific process are removed from the evaluated comparison matrices for better readability.

C.   PROCESS AREAS AT LEVEL 2

1.   Staffing

With the size and complexity of today's software, the number of people involved in the typical project has grown. These people need to be recruited, organized and allocated to specific tasks to provide the human resources required for development. The QMM questionnaire addresses the activities concerning staffing of the project. All goals of the process area staffing of the P-CMM are covered.

2.   Communication and Coordination

The QMM highlights the importance of internal and external communication within a software development project. Questions concerning communication practices are even allocated a specific part within the questionnaire, and communication aspects are covered in detail. All goals of the process area staffing of the P-CMM are covered.

3.   Work Environment

Provision of proper physical environment and resources is mainly seen as a responsibility of the organization. In contrast, the QMM contains questions about adequate attention and responses of the project management to problems in this process area. Possible resulting risks from deficiencies in the physical environment or resources are also covered in the risk management part of the QMM. The process area work environment is not a main focus of the QMM, but the process goals are covered.

4.   Performance Management

Performance Management has two aspects – one looking at the people whose performance is managed, the other looking at the estimation and planning issues. The P-CMM as a self-contained model addresses both aspects in this process area, while the QMM addresses estimation and planning in the respective part of the questionnaire. In the combination of the questions from

different sections the QMM addresses all goals of the process area performance management.

5. Training and Development

The QMM treats training as an activity that needs to be carefully planned. Education and planning of training are seen as tasks of project management. The QMM addresses the relevant goals of the process area training.

D. PROCESS AREAS AT LEVEL 3

1. Competency Analysis

At the unit level, competency analysis is related to planning and scheduling activities. Lack of capabilities may also pose risks that need to be managed. The QMM consequently focus on the effects of availability or lack of availability on a project. It addresses some aspects of competency analysis in the risk management and estimation/planning part. The evaluation of a formal establishment of work processes is underlying numerous questions that ask whether activities are formalized or are conducted regularly. In the combination of the questions from different sections the QMM addresses all goals of the process area competency analysis that are relevant for the unit level.

2. Workforce Planning

At the unit, level workforce planning is interwoven with project planning, and activities are performed to satisfy project-competency needs. In the combination of sets of questions from the estimation/planning and the people management area, the QMM covers the relevant goals of the process area workforce planning.

3. Career Development

The program manager will contribute to career development activities on the organizational level by providing performance information. On the unit level, the program manager has to be active in career development practices that require direct interaction with and knowledge of the individual in question. These activities are directly evaluated via the QMM questionnaire. The process goal of the process area dareer development that is relevant for project management is covered.

4.   Participatory Culture

During the development of the QMM, emphasis of the survey instrument was placed on culture and leadership aspects [Machniak 99]. The QMM can be used to explore behavioral aspects of leadership affecting the micro-work environment beyond the more formal view of the P-CMM. All goals of the process area staffing of the P-CMM are covered.

E.   PROCESS AREAS AT LEVEL 4

1.   Empowered Workgroups

A project team with the project manager granted responsibility and authority constitutes an empowered workgroup. Partitioning of the project team in further empowered workgroups depends on the size and complexity of the project, which is represented in the project's work breakdown structure. Aspects regarding delegation of responsibility and partitioning of work are addressed in the QMM. The relevant goals of the process area Empowered Workgroups are covered in the QMM.

2.   Quantitative Performance Management

Quantitative performance management is a core task for a project manager. Performance objectives are the necessary base for realistic planning and scheduling of work. Corrective actions are a key management activity when the performance achieved differs from the objectives. The QMM contains questions addressing quantitative performance management in its people management section, but establishes further on in its questionnaire a specific section (Estimation/Planning Management) to explore estimation, planning and scheduling aspects of project management in detail. The goals of the process area quantitative performance management are covered in the QMM.

F.   PROCESS AREAS AT LEVEL 5

1.   Continuous Capability Improvement

Project managers should aspire to improve project team capabilities and processes even if the project is on schedule without cost overruns or other

problems. The ability to recognize improvement opportunities requires technical knowledge, interest in further professional and technical education, and participation in problem solving. The QMM addresses these factors. It evaluates whether the project manager has the necessary background to be aware of technical options, whether he is aware of the organizational and program status, possible problems and whether he listens to ideas and proposals. The goal of continuously improving the capability of operating and competency-based processes is not directly addressed by the QMM questionnaire. The questions contained in the QMM however ask for behavior, activities and necessary knowledge that provide a base for implementing improvements.

Note that at the project management level, possible benefits of changes have to be compared to the impacts and risks generated from changing operating or competency-based processes in a running program. A program manager might be aware of possible improvements but decide not to implement them based on risk-management considerations. Even if the P-CMM raises goals concerning continuous capability improvement, it must be accepted that at the unit level, project necessities may hinder continuous implementation. The QMM questionnaire accommodates this situation. It does not penalize the program manager if he does not implement continuous improvement. It evaluates instead whether the necessary base for improvements is laid that enables the project manager to implement improvements if the project situation allows.

Implementation of a question addressing improvement efforts (within given project constraints) might increase direct coverage of the process area goals. However, with regard of the different focus of QMM and P-CMM, this thesis sees the implementation of this process area in the QMM as being acceptable.

2. Organizational Performance Alignment

Performance alignment on the unit level is connected to task assignment, (i.e., planning activities like establishing a work breakdown structure), to problem solving in case of insufficient performance, and to leadership aspects such as reinforcement for performance. These activities are covered by the questions of the QMM. Institutionalization of these activities is further on covered implicitly by

the questions of the estimation/planning management part of the QMM. The goals of the process area Organizational Performance Alignment with relevancy on the unit level are covered in the QMM.

3. Continuous Workforce Innovation

The situation in the process area continuous workforce innovation is similar to the situation in the process area continuous capability improvement. Project managers should aspire to improve workforce practices and technologies even if the project is on schedule without cost overruns or other problems. The ability to recognize improvement opportunities requires technical knowledge, interest in further professional and technical education, and participation in problem solving. The QMM addresses these factors. It evaluates whether the project manager has the necessary background to be aware of technical options, whether he is aware of the organizational and program status, possible problems and whether he listens to ideas and proposals. The goals of identifying, evaluating and deploying innovative or improved practices and technologies are not directly addressed by the QMM questionnaire. The questions contained in the QMM however probe the behavior, activities and necessary knowledge that provide a base for implementing innovative or improved practices and technologies.

Similar to the process area continuous capability improvement, note that at the project management level possible benefits of changes have to be compared to the impacts and risks generated from implementing innovative or improved practices and technologies in a running program. A program manager might be aware of possible improvements but decide not to implement them based on risk management considerations. Even if the P-CMM raises goals concerning continuous workforce innovation, it must be accepted that at the unit level project necessities may hinder implementations. The QMM questionnaire accommodates this situation. It does not penalize the program manager if he does not implement improvement or innovations. It evaluates instead whether the necessary base for recognition of innovations is laid that enables the project manager to implement innovations if the project situation allows.

Implementation of a question addressing innovation efforts (within given project constraints) however might increase direct coverage of the process area goals. However, with regard of the different focus of QMM and P-CMM, this thesis sees the implementation of this process area in the QMM as being acceptable.

V. FINDINGS AND RECOMMENDATIONS

A. FINDINGS

1. COMPLIANCE OF QMM WITH P-CMM

The People Capability Maturity Model and the Quality Management Metric have different objectives. The P-CMM addresses the problems of managing an organization's workforce. It categorizes five levels of maturity with associated capabilities and suggests specific processes and practices to achieve these capabilities. Processes and practices are addressed on the individual, unit and organizational level. It does not provide a ranking of processes and does not provide indications about possible implications of processes on success of software development projects.

In contrast, the QMM measures the quality of software development management with regard to its impact on project success. It does not evaluate the capability of the organization; instead it focuses on the situation in a specific project. The QMM can be used to compare characteristics, practices, and specific behavioral aspects of the project manager against a set of ideal characteristics, best practices and positive leadership behavior. These elements are ranked in accordance with their respective impact on project success. The number of questions addressing a specific process and their level of detail depends on the importance of this process for the project success. A process with higher importance will be evaluated in a more detailed way than a supportive process. The QMM does not, however, question every implementation detail and allows projects to choose different implementations as long as the underlying goals are pursued.

Due to their different objectives, QMM and P-CMM are not fully congruent with one another. The P-CMM addresses processes on the organizational level that are not the responsibility of project management and therefore are not addressed by the QMM. The P-CMM also maintains a uniform level of detail in describing processes while the level of detail in the QMM depends on the

contribution of the respective element to the project success. The QMM then also covers elements the P-CMM does not as they do not represent processes. Behavioral aspects and also some procedural aspects of the leadership style of the project manager are evaluated by the QMM as these aspects definitely have an impact on motivation of personnel and on the micro-work environment in the program, and hence, on project success. Finally there are some differences in wording that are attributed to the different orientation and purpose of P-CMM and QMM.

Except for these objective - and purpose - related differences the QMM is in conformance with the P-CMM. The QMM questionnaire covers all processes of the P-CMM with relevancy for project management. The scoring of the QMM further on honors if project-established processes are conformant to processes described by the P-CMM. The QMM adds some additional questions regarding behavioral and procedural aspects on the implementation level that are beyond the scope of the P-CMM. Questions and scoring of the QMM however are in no case contradictory to the P-CMM, as the QMM in many respects subsumes the P-CMM. Overall the QMM represents a metric tool that evaluates the quality of people management on the project level in conformance with the P-CMM.

2. RELATION OF QMM QUESTIONS TO P-CMM

The QMM is not derived from the P-CMM. It is developed to measure the quality of management in a software development project with regard of its impact on the probability of success of the software development effort. Wording, detail level and organization of the questionnaire consequently differ from wording, detail level and organization of processes in the P-CMM.

The questionnaire contains some questions addressing behavioral and procedural aspects on the implementation level that are beyond the scope of the P-CMM (see Table 17). Most of the questions, however, are correlated to processes that are contained in the P-CMM (see Appendix B). It is therefore possible for all P-CMM processes relevant for project management to identify related questions in the QMM. With regard of the intention of the QMM, it is also possible and even more important for all questions (except questions addressing

behavioral and procedural aspects) to identify processes that are related to a given question.

If the results of a QMM survey indicate a low probability of success for a specific software development project due to management deficiencies, the relation of questions to processes will allow the identification of deficient processes and subsequent systematic improvement efforts.

3. QMM AS QUANTITATIVE PERFORMANCE MEASUREMENT TOOL

The purpose of quantitative performance management is to predict and manage the capability of competency-based processes to achieve measurable performance objectives. Performance characteristics are identified, measured and analyzed to allow performance management.

Project management by itself is a competency-based process that contributes to the performance of unit objectives, that is, to the performance and success of a software development project. The performance objective of project management is to achieve successful software development. The underlying management processes determine the performance characteristics of project management.

Previous work by Machniak [Machniak 99] and Grossman [Grossman 00] established and validated the QMM as a methodology to quantify the quality of project management and to predict success of the managed software development project. The QMM score therefore can be used as a measurable performance objective. This thesis shows that the QMM is in compliance with the P-CMM and its processes, that is, that measurable performance characteristics form the base of the QMM questions. The relation of QMM questions to P-CMM processes allows specific identification of deficient processes in case of deficiencies.

In consequence the QMM can be used as a quantitative performance measurement tool as described on the predictable level of the P-CMM. The QMM allows one to measure performance characteristics of project management, and

to both predict and manage performance objectives (i.e., success probability). Based on the correlation of QMM questions and P-CMM processes, users can take corrective actions when the predicted performance deviates from objectives.

B. RECOMMENDATIONS FOR FUTURE WORK

The recommendations for future work include updating and further testing of the QMM survey instrument, analyzing and assessing the effects of using QMM as a measurement tool in quantitative performance management, and integrating the QMM survey instrument results into existing cost, schedule and risk models to improve program estimation accuracy.

Updating the QMM survey instrument includes updating the focus of the survey instrument, updating the organization of questions, refining the wording of questions, and refining the weighting of questions. Software development management methods are changing on a continuous basis. The QMM survey instrument needs to be updated to reflect these changes and to ensure that its focus is on the management aspects relevant for the success of software development. Changes in methods and technologies might also cause replacement of questions or changes in the weighting of questions.

The QMM partitions questions into the four management areas: people management, estimation/planning management, risk management, and requirements management. As maturity models such as the P-CMM become widely used, the allocation of questions should be revised for a better alignment of the survey instrument with the corresponding models.

The QMM survey instrument requires ongoing validation. The QMM should also be applied to software development projects of different size to determine possible needs for adjustments of the weighting factors based on project size.

The correlation of QMM elements to process goals of the P-CMM allows determining people management processes that need implementation or improvement based on the QMM results. In combination with the aforementioned validation activities, one could assess the effects of using the QMM as a

measurement tool in quantitative performance management as a basis for adjusting measures of correlation between QMM and P-CMM.

This thesis focused on the people management part of the QMM as its highest weighted part. The correlation between QMM and P-CMM provides a feedback to the program manager, helping him to identify processes that need implementation or improvement. Further research is required to evaluate the questions of the other QMM management areas and to relate them to other models where applicable.

Previous QMM surveys have been executed using a paper form of the questionnaire. An introduction had to be given to the survey attendants as the questions are formulated quite tersely for practical reasons. The development of an automated, preferably web-based QMM survey tool would generate a number of benefits. Integrated help functions and information texts would reduce the need for an introduction. The survey could be conducted when convenient for the project manager without the need for a researcher or examiner to be present. Scoring of questions and relations between answers and success probabilities or improvement suggestions could be concealed to prevent biased answers. Data from different surveys could be used to indicate trends, and data from different projects could be more easily analyzed and compared.

One could also investigate how the QMM results should be used as input to estimation models to improve the accuracy of estimations. Currently these models do not consider the quality of software-development management. If the performance of software-development management is managed quantitatively, at best all possible deficiencies are eliminated. Thus, even an initially deficient management might be able to improve its performance and finally perform as a good management. In this case, no adjusting inputs to current estimation models are necessary. In all other cases an input factor to estimation models based on the quality of management would increase the accuracy of estimations.

From [Machniak 99]

Pair choice section ONE: (Requirements Management) choose most applicable term of the two for each row (page 1 of 2):

2	Formal requirement list	1	Informal requirement list
2	Written requirements	0	Oral requirements
1	Requirements informal, but recorded	0	Requirements not recorded
2	Requirements as part of an SRS (or other formal repository)	1	Requirements informally recorded
0	Requirements taken as is from customer	2	Look to reformulate, interview in-depth, or otherwise re-validate
1	Only one development strategy used	0	Strategies not consistent, used at different times
2	Stakeholders as part of requirements development	1	Stakeholders approve requirements after formulated by development team
2	Requirements are testable	0	Requirements have no test plans
0	Informal test plan or no test plan	2	Formal test plan
1	Test team involved with requirements	0	No test team input or plans during requirements development
0	Only a percentage of requirements present in baseline	2	Baseline must contain all requirements
1	Requirements documentation has hierarchical structure	0	All requirements must be implemented
1	Requirements have listed responsible party	0	Requirements origin not important
2	Requirements documentation have versions	0	No requirements history
1	Requirements have specific attribute values	0	Requirements all rank evenly
0	Funding controls requirements definition	1	Requirements definition controls funding
1	Requirements are top down	2	Requirements are bottom up
1	Users/stakeholders are identified and interviewed (market survey)	0	No special consideration to identify users/stakeholders
3	Each requirement has a singular concept	0	Some requirements are compound statements
0	Requirements definition minimized when funding short	1	Program scope may reduce, but requirements definition completed
1	Requirements extraction has formal process	0	Requirements extraction ad hoc
1	Change procedures formal	0	Change procedures ad hoc
1	Users/stakeholders somehow involved in requirements definition	0	Program team only involved in requirements definition
0	Management sets requirements for developers	1	Developers at least partially involved in setting requirements
0	Requirements changed at least once since baseline established prior to new version	1	Requirements in baseline has not changed prior to new version or upgrade
0	No ranking of requirements	1	Requirements have priorities assigned
2	Use-case diagrams (or other models or scenario developments)	0	No models used for requirements extraction
0	Requirements changes informal	1	Requirements changes formal
1	Plan to "freeze" requirements as some designated milestone	0	No provision for "freezing" requirements
1	Requirements must be traceable	0	Origin of requirements not important
3	Requirements must be testable	1	System developed must be testable
2	Test plans to determine requirements implemented	0	No test plans needed for requirements verification
1	Requirements have priorities in implementation	0	All requirements must be implemented
0	Some requirements have multiple statements or ideas	2	One idea, one statement per requirement

Requirements Management (page 1 of 2) score _____

Program Name _____   Date _____

Page 1 of 8

Figure 5.   Requirements Management Pair Choice Questions Page 1 (from: Machniak 99])

ANSWER THIS BLOCK OF QUESTIONS ONLY IF A SEQUENTIAL OR WATERFALL APPROACH IS USED FOR DEVELOPMENT (Requirements page 2 of 2)

Score	Statement A	Statement B	Score
1	Requirements first, then initial development work	Initial development work then requirements	0
1	Requirements documentation driving development	Requirements documentation developed in parallel/after development	0
1	User feedback considered during development	After development starts, user feedback serves as input to new work	0
1	Change management procedures used strictly	Change management procedures as guidance only	0
0	Design decisions prior to or in parallel to requirements development	Design decisions only after approved requirements stabilized	1
0	Requirements summarized what we have developed	Requirements are the blueprint for development	1
2	Length of time for requirements work greater than development work	Length of time for requirements work less than development work	0
0	Requirements have design detail	No design detail in requirements	1
1	Requirements creep to be avoided	Requirements creep o.k., but need to be controlled	0
1	Freeze requirements at some point	Requirements are fluid throughout development	0
1	Formal change procedure	Informal change procedure	0
2	Change management plan	No change management plan	0
0	Requirements ambiguity always present to some extent	Requirements ambiguity unacceptable at any level	2
0	Testing considered up front during requirements determination	Testing considered down the line during development	1
2	Requirements development team members different from implementation	Those working on requirements, work on implementation	1
0	Start implementation as early as possible to help define requirements	Requirements must be defined prior to any implementation work	2

ANSWER THIS BLOCK OF QUESTIONS ONLY IF A PROTOTYPING, THROWAWAY, SYNCHRONIZE & STABILIZE, OR OTHER STRATEGY USED

Score	Statement A	Statement B	Score
1	Develop prototype, then determine requirements	Determine requirements prior to any development work	0
1	Requirements testing done after each iteration	No testing	0
1	Individual changes as necessary	Only block changes made	0
0	Development team decides on changes after iteration	Users involved with changes	1
1	Changes based on feedback only from user for correction of problems	Changes to upgrade system and correct problems	1
1	Funding controls changes and change procedures	Changes control funding	1
0	Requirements documentation finalized prior to development	Requirements fluid throughout development (only freeze at end)	2
1	Requirements test plans completed prior to development	Requirements test plans completed after development	0
0	Requirements first, then initial development work	Initial development work then requirements	1
2	Use development effort to learn more about requirements	Define all requirements prior to coding anything	0
1	Requirements ambiguity always present to some extent	Requirements ambiguity unacceptable at any level	0
1	Requirements have design detail	No design detail in requirements	1
1	User feedback considered during development	After development starts, user feedback serves as input to new work	0
2	Get something to users as soon as possible for evaluation	Make sure it is complete before releasing	0
0	Management dictates requirements	Develop't team visually represent requirements through rapid prototyping	1
1	New requirements allowed after initial requirements defined	New requirements not allowed	0

Requirements Management (pg 2 of 2) score [ ] **+ pg 1 score** [ ] **= TOTAL SCORE** [ ] **Enter on QMM scoresheet blk a.**

Program Name _____   Date

Figure 6.   Requirements Management Pair Choice Questions Page 2 (from: Machniak 99])

Pair choice section TWO: (Estimation/Planning Management) choose most applicable term of the two for each row (page 1 of 2):

Score	Term	Term	Score
1	At least one estimation method used in program	No estimates	0
0	Formal derivation of product metric for estimation of size	Ad hoc size estimation	0
0	Ad hoc process evaluation	Formal derivation of at least one process metric	1
1	Develop work breakdown structure (WBS)	Assign work as needs arise	0
0	Estimates are developed to fulfill a data call only	Use estimates to plan program	1
0	Use estimates to sell program only	Estimates are useful to the project team for planning purposes	1
1	Resource evaluations made for program	No resource evaluation for planning	0
0	Use both bottom up & top down for estimate, use one stakeholders like	Use both bottom up & top down and evaluate significant differences	1
0	Estimates made and not updated	Estimates updated throughout program	1
1	Resource estimations used to adjust product size estimate	Estimations made irregardless of resources available	0
0	Estimations made to fit budget	Budget made from estimations	1
0	Estimations compromised to get program	Rather risk loss of program than compromise confident estimations	1
1	Cycle time estimations	No cycle time estimations	0
1	Event count estimations	No event count estimations	0
1	Lines of code (LOC) estimation	No LOC estimation	0
1	Function Point (FP) estimation	No FP estimation	0
1	Estimates by algorithmic methods	Estimates by analogy	1
1	Expert judgement for estimation	Ad hoc estimates	0
1	Estimates by algorithmic methods	Ad hoc estimates	0
0	Expert judgment for estimates	Estimates by analogy	0
0	Ad hoc estimates	Estimates by analogy	1
1	Bottom up estimates	Expert judgement	1
1	Top down estimates	Expert judgement	0
0	Ad hoc estimates	Any other estimate process	0
1	Fuzzy logic estimating method	No formal estimation methodology	1
1	WBS development from estimates	WBS development in parallel or prior to estimation completion	0
1	Critical path of program determined	Tasks developed but no path is identified	0
1	Estimators are program team members	Estimators are outside program team	0
0	Management only on estimations	All team members involved in estimation process	1
1	Estimates updated at reviews	No updates of estimates	0
0	Estimates updated at reviews	Estimates constantly updates (in between reviews, too)	1
1	Estimate procedures stay the same	Estimate procedures change	0
1	Stakeholders are part of estimation process	Stakeholders brief estimations after completion	0
1	Estimates are used beyond initial selling of program	Estimates are one time events, used for a specific purpose once	0
1	WBS has objective measure of completeness	Important to have WBS as guide, not rigid implementation	0

Estimation/Planning Management page 1 of 2 score [ ]

Program Name _____

Date _____

Figure 7.   Estimation/Planning Management Pair Choice Questions Page 1 (from: Machniak 99])

Left term			Right term
Life cycle estimates	1	0	Estimates for program initiation only
System upgrades (SCR) software change requests estimated individually	1	0	Systems upgrades estimated as whole
Estimates for on-going resources needed to maintain s/w	1	0	Estimates for maintenance not done
Informal re-estimates during development	0	1	Formal re-estimates at pre-defined milestones
Formal re-estimates when amendment changing the system is introduced	1	0	Informal re-estimates when amendment changing the system
person in-charge of estimation walks in a managers office to get an opinion	0	1	Meeting(s) organized for purpose of performing cost estimations
Factor analysis prior to commencement of program	1	0	None done
Change control procedures set in place	1	0	No set procedures
Elapsed time and actual work time estimates	1	0	one or the other or neither
No schedule created	0	1	Schedule created
Schedule not updated	0	1	Schedule updated
Schedule followed	1	0	Schedule not followed
Tasks identification arises as program progresses	0	1	Detailed level tasks identified prior to program initiation
Scope of program understood by all	1	0	Scope not explicitly defined
Quality factors and criteria identified	1	0	No explicit quality factors defined
No project tracking tools used	0	1	Project tracking tools used
CSCIs identified and tasked	1	0	CSCIs not explicitly identified
Expectations are managed via estimations	1	0	Estimations are made to fit preconceived expectations
No cost schedule developed	0	1	Cost schedule developed
No resource schedule developed	0	1	Resource schedule developed
Team members, management know at any time if in budget & schedule	1	0	Exact budget & schedule status somewhat unclear to at least some
Individual program phases are estimated	1	0	Only top level program estimated
Stakeholders/users emphasis understood- quick to field or all complete	1	0	Program management sets delivery tradeoffs without outside input
Testing planned with initial program planning	1	0	Testing no in initial planning
Documentation not considered in initial planning	0	1	Documentation part of initial planning
Hardware considered in estimations	1	0	Software only considered
No formal schedule/cost tracking	0	1	Formal procedures established for tracking cost and schedule
Earned value set up	1	0	Earned value not used
Estimations omit documentation planning	0	1	Documentation in estimates
Training omitted in estimates	0	1	Training part of estimates
Earned value set up, but not tracked	0	1	Earned value tracked
Detailed planning done with incomplete set of requirements	0	1	Detailed planning done with detailed set of requirements
Complete infrastructure support mechanism understood for estimations	1	0	No consideration of infrastructure done for estimations
Team possibilities considered for planning of program	1	0	No consideration for outside teaming possibilities
Work Breakdown Structure (WBS) set up	1	0	No WBS completed

Estimation/Planning Management pg 2 of 2 score [ ] + pg 1 of 2 score [ ] = TOTAL SCORE [ ] Enter QMM scoresheet blk b.

Program Name _____   Date_____

Figure 8.   Estimation/Planning Management Pair Choice Questions Page 2 (from: Machniak 99])

Pair choice section THREE: (People Management) choose most applicable term of the two for each row (page 1 of 2):

Human Resources

Left	L	Right	R
Program team members have clearly defined, segmented roles	0	Work responsibilities are shared	1
Formal team building procedures are used	1	No formal team building emphasized	0
Program manager flexible regarding work hours	1	Program manager maintains strict standards for work hours	0
Big picture conveyed to all team members by program management	1	Program management focuses on the partitioned tasks with team	0
People issues dealt with primarily through indirect methods (email, memo, etc)	0	People issues dealt with primarily through direct methods (face-to-face)	1
Training is required and planned on a regular basis	1	Training is ad hoc	0
Each team member is educated on and understands overall program and their roles	1	Team members only know their respective areas	0
Consideration for team members' career goals are reflected in assignments	0	Team members must adapt to tasks that are assigned	0
Team members assignments and responsibilities are mostly dictated by PM	0	Assignments and responsibilities are discussed and agreed upon with PM	1
Management leads in problem solving	0	Management facilitates and lets team lead in problem solving	1
Management welcomes problems as challenges and opportunities	1	Management views problems as obstacles and grounds for punishment	0
Team members participate in performance evaluations of peers	1	Personnel evaluations are strictly PM responsibility	0
Management reinforcement feedback sparse and inconsistent, if any	0	Management provides timely reinforcement feedback for positive behaviors	1
Management provides basic needs of office facilities fairly well	1	Office facilities are a drawback to working in the program	0
Working conditions are fairly comfortable, time off policy "flexible"	1	Working conditions and time off policy is inconsistent and difficult at times	0

Communication:

Left	L	Right	R
Communications primarily written (email, memo, etc.)	1	Communications primarily verbal (face-to-face)	1
Detailed instructions: oral presentation, follow-up email, memo, etc.	1	Email, memo, etc. only	0
Formal communication protocol	1	Informal communications	0
External vertical communications restricted	0	External vertical communication allowed	1
Coders notebook, weekly accomplishment reports required	1	Not required	0
User-coder relationship established, encouraged, and mediated	1	User-coder interaction minimized	0
Meetings structured to minimize wasted time	1	Meetings unstructured and open ended	0
Meetings have agenda, objectives, and conclude with action items	1	Meeting agenda fluid and open ended	0
Program management and coder communication face to face	1	Program management and coder communication primarily email	0
Program team updated regularly regarding organizational & program status	1	Meetings infrequently scheduled	0
Open communications is encouraged	1	Communication through chain of command only is encouraged	0
Program manager accessible for discussions	1	Program manager difficult to get an appointment to see	0
Program management (PM) is viewed as separate from team	0	PM mixes with team frequently	1
Management regularly holds team meetings	1	Meetings are sporadic	0
Meetings are structured with definite goals and objectives	1	Meetings are informal	0
Program management is generally easy to reach and talk to	1	PM is usually hard to get a hold of and difficult to talk to	0
Team-program manager relationship adult-adult	1	Team-program management relationship parent-child	0
Schedules are spontaneous and poorly communicated	0	Schedules must be fixed and rigidly followed and formally reported	1
work is seen as complex processes involving team working together	1	Work broken into pieces with minimal team member interaction	0
Action items sometimes are not followed through	0	Action items communicated and followed through thoroughly	1
Team members require frequent clarifications by PM for assigned tasks	0	Team members rarely require clarifications by PM for assigned tasks	1

Program Name _____ Date _____

Figure 9. People Management Pair Choice Questions Page 1 (from: Machniak 99])

Pair choice section THREE: (People Management) choose most applicable term of the two for each row (page 2 of 2):

Leadership:

Left		Right	
Long range organizational vision	1	Short term program and immediate work focus	0
Lead through personal attention to others	1	Action-oriented leadership approach	1
Run as much of the organization as possible	0	Let team make decisions as much as possible	1
Direct and domineering style	0	Encourage independence in others	1
Traditional leaders respect hierarchy	0	Do what needs to be done	1
Win cooperation rather than demand it	1	Tough-minded with others	0
Act strongly and forcefully in the field of ideas	0	Prefer to lead other independent types while seeking autonomy for self	1
Consults with team members to find solutions to problems	1	Consults team members to get validation of PM's predetermined solutions	0
Keep people well informed	1	Only as much knowledge as necessary for their work	0
Make things happen by focusing on the immediate problems	1	Long range focus and de-emphasize current problems	1
Manage others loosely and prefer minimal supervision	1	Follow traditional procedures and rules conscientiously	0
Leadership, management decisions exclusively by program management	0	Program management makes decisions but gets inputs from team	1
Team-program manager relationship adult-adult	1	Team-program management relationship parent-child	0
Program management makes decisions but gets inputs from team	0	All program team members responsible for program decisions	1
When a problem arises: management takes over to solve it	0	Management lets the team solve the problems	1
Leadership is do as I say, not do as I do	0	Leadership by example	1
Program expectation not influenced by PM	0	Program expectation managed by PM	1
PM gives freedom to team, but does has no mentoring for members	0	PM empowers teams by mentoring members to be leaders	1
Program management waits and sees what happens then plans	0	Management plans far in advance	1
Program management is reacts to emergencies	0	Management is one step ahead of problems	1
Facilitative approach to solving problems	1	Take charge readily and often	0
Program management is complex, takes much time to understand	0	Management is simple, easy to figure out	1
Program management prefers to plunge right in	0	Takes time to separate things to be done and order of doing them	1
Program management reacts to needs of the moment	0	Methodically follows plans	1

Technical Competency of the program manager:

Left		Right	
PM has technical experience particular to the particular s/w program	1	PM relies on team members solely	0
PM participates in technical reviews	1	PM only in non-technical reviews	0
PM participates in making technical decisions when problems arise	1	PM delegates technical questions	0
PM does not get involved discussing technical options	0	PM contributes to technical options being discussed	1
PM does not review technical options and decisions	0	PM reviews technical options and decisions	1
PM actively attempts to keep up-to-date with current technology and standards	1	PM is removed from cutting edge technology issues	0
PM receives technical periodicals and occasionally references applicable articles	1	PM doesn't read periodicals nor references current articles to team	0
PM doesn't have technical background (or education)	0	PM has technical background (or education)	1
Team members avoid PM when they need technical advice	0	Team members generally consider talking to PM regarding technical issues	1

HR [ ] + Comm. [ ] + Leadership [ ] + Tech. Competency [ ] = People Mgmt. score [ ] Enter on blk c.

Program Name _____   Date _____

Figure 10. People Management Pair Choice Questions Page 2 (from: Machniak 99])

Pair choice section Four: (Risk Management (RM)) choose most applicable term of the two for each row (page 1 of 2):

	Left statement	Right statement	
1	RM is formal and documented	RM is informal, if at all	0
1	A risk management plan exists	No risk management plan is developed	0
0	RM is more of a data call than a useful document	RM drives decisions on the program	1
0	RM is done prior to the program beginning	RM is done prior and during program execution	1
0	RM is only done during the program execution	RM is done prior and during program execution	1
0	Risks are generalized through the whole program	Risks are categorized	1
0	Risk management is done internally, only	An outside organization also contributes to the RM process	1
0	Risk is a management function	Risk is a program team function	1
1	Risk are precisely articulated	Risks are generalized, if at all	0
1	Each risk has a consequence	Consequences are generalized, if at all	0
1	A mitigation strategy is completed for each risk	Mitigation strategy is generalized, if at all	0
1	Contingency plans are developed for a RM plan	Contingency plans are ad hoc as problems arise in the program	0
1	Risks are anticipated	If problems arise, management will deal with it	0
0	The program doesn't have any risk	Programs that do not have risk, have problems	1
0	Risk management is automated	Risk management may use tools, but depend on human input	1
1	Risks are assigned probabilities	Probabilities are not relevant for RM	0
0	All risks are potential problems, relative priorities for risks are not useful	Risks are weighed relative to other program risks and thus prioritized	1
0	Risk management information is only shared internally	Risk management information is shared with all stakeholders	1
0	Risk analysis uses ordinal rankings	Risk analysis uses actual measurements with a mathematical model	1
1	Regret analysis used	No regret analysis done	0
1	Attach probabilities to future events	No probabilities associated with future events	0
0	Assessing risks with mechanical methods	Risks should be compared to other risks and sorted	1
1	Risk status tracked	Not tracked	0
1	Technical risks examined	No technical risks examined	0
1	Process risks examined	No process risks examined	0
1	Product risks examined	No product risks examined	0
1	Stakeholder/user risks examined	No examination of stakeholder/user risks	0
1	Checklists used to identify risks	No checklists used	0
1	Risks are tracked	No tracking or monitoring of risks	0
1	Each risk has an impact	No impact analysis of risk	0
1	Each risk has a mitigation plan	No individual risk mitigation	0
1	Risks monitored by priority	No special attention to track higher priority risks	0
1	Risk assessment is formalized	No formal risk assessment	0
1	Risk control is formalized	No formal risk control	0
0	Integration risks not considered	Integration risks examined	1

Risk Management page 1 of 2 score

Program Name _____

Date

Figure 11.　Risk Management Pair Choice Questions Page 1　(from: Machniak 99])

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Pair choice section Four: (Risk Management (RM)) choose most applicable term of the two for each row (page 2 of 2):

	Left option	Right option	
1	Risks to cost	No cost risks examined	0
0	Unforeseen risks have occurred in program	Any risk that came up had been identified previously	1
1	Personnel risks examined	No personnel risks examined	0
1	Estimation risks examined	No estimation risks examined	0
1	Planning risks examined	No planning risks examined	0
1	Requirements risks examined	No requirements risks examined	0
1	Resource risks examined	No resource risks examined	0
1	Risk management plan updated regularly	No regular risk management plan updates	0
1	Risks charted	Risks not charted	0
1	Performance risks examined	Performance risks not examined	0
1	Program management self risks examined	No program management risks examined	0
1	Risk from program constraints examined	No program constraint risks examined	0
1	Each category of risks are prioritized	No prioritization	0
1	Each category of risks are evaluated for impact	No impact analysis performed	0
1	Each category of risks have control strategy	No control strategy	0
1	Documentation risks examined	No documentation risks examined	0
1	Regret matrix tracked	No regret matrix or not tracked	0
1	Communication of risk activities are facilitated	No facilitation or promotion of communication of risk activities	0
1	Taxonomy-based questionnaire used to identify risks	Taxonomy-based questionnaire not used	0
1	Associated hardware risks examined	No consideration for hardware risks	0
1	Integration risks examined	Integration risks not examined	0
1	Communication risks examined	Communication risks not examined	0
1	Leadership risks examined	Leadership risks not considered	0
1	Risk avoidance considered for certain risks	Risk avoidance not considered for risks	0
1	Risk documentation forms used	No risk documentation forms used	0
1	Dependency risks examined	No dependency risks examined	0
1	Alternatives like risk avoidance considered for high risk items	No consideration of risk avoidance	0
1	Documented risk statements use a condition-consequence type format	Condition-consequence of risk statements not clearly defined	0
0	No assignment of ownership of risk mitigation action	Each risk mitigation action is assigned to an individual for resolution	1
1	Calculation of risk exposure made (probability X loss, for each risk)	No risk exposure calculations	0
0	Oral communication of risks only	Risks written in a way that communicates nature and status of factors	1
1	Triggers used to quantify risk conditions present	Risk conditions present are all subjective	0
1	Risk "czar" in program for monitoring risks	No special positions/responsibilities for risk monitoring	0
1	Post-program review completed (scheduled) for unanticipated problems ID	No post-program reviews completed or scheduled	0
0	No schedule risks examined	Risks to schedule investigated	1

Risk Management pg 2 of 2 score ☐ + pg 1 of 2 score ☐ = TOTAL SCORE ☐ Enter on QMM scoresheet blk d.

Program Name _____ Date

Figure 12.   Risk Management Pair Choice Questions Page 2 (from: Machniak 99])

No.	Requirements Management Questionnaire	Yes	No	N/A
1	PM chose to have a formal requirements list	1	0	0
2	Requirements recorded in some way	2	-1	0
3	Written requirements were part of some formal document	1	0	0
4	Written requirements were informal	1	2	0
5	At least some requirements were oral only	-2	1	0
6	All stakeholders were identified	2	-1	0
7	All stakeholders participated in the requirements extraction	2	0	0
8	Some stakeholders participated in the requirements extraction	1	0	0
9	Management extracted requirements, no stakeholder involvement	1	2	1
10	Management passed requirements to development team	1	0	0
11	Stakeholders not involved in Management extraction, but approves	-1	0	0
12	Management gets inputs from stakeholders, then develops requirments	1	0	1
13	Developers work informally with users to arrive at requirements	1	0	0
14	Same as 13, but management oversees and formalizes	2	0	0
	If a waterfall or sequential development strategy:			
15	All requirements complete before design	1	-3	0
16	Some requirements left incomplete prior to design	-1	0	0
17	Requirements informal prior to design effort	-1	0	0
18	Requirements serve as input	1	-1	0
19	Length of time for requirements work greater than development work	2	-1	0
20	Requirements developed in parallel to design	-1	1	0
OR	*If a prototype, throwaway, or other development strategy:*			
15	Learn about requirements through development efforts	1	-1	0
16	No coding until all requirements are defined	-3	1	0
17	Requirements formal prior to design effort	-1	0	0
18	Requirements serve as output	1	-1	0
19	Requirements definition work in parallel to development efforts	2	-1	0
20	Requirements developed in parallel to design	1	-1	0
21	Are requirements frozen at some phase	1	-1	0
22	Change management exists	3	-3	0
23	Change management is formal	1	0	0
24	Project strategy is consistent throughout development	1	0	0
25	Requirements are updated	1	0	0
26	Configuration Management (CM) exists	3	-3	0
27	CM is formal	1	0	0
28	Requirements are testable	2	-2	0
29	Requirements testing considered/implemented during extraction	2	0	0
30	Requirements testing plan exists	2	0	0
31	Requirements testing is formal	1	0	0
32	All requirements have priorities	2	-2	0
33	All requirements must be implemented	0	1	0
34	Requirements are tested	1	-1	0
35	All requirements are equally important	0	1	0
36	At least some requirements have priorities	1	0	0
37	All requirements are traceable	1	0	0
38	Traceability not important	0	1	0
39	Each requirement has an author	1	0	0
40	Who authored requirement is not important	0	1	0
41	Initial set of requirements to be implemented, no requirements creep	0	1	0
42	Structured and tracked changes to requirements only	1	-1	0
43	Change is inevitable, changes allowed at all times	-1	1	0
44	Change is inevitable, but changes limited	1	0	0
45	Requirements control funding	1	0	0
46	Requirements history kept	1	-1	0
47	Baseline established for requirements at some point prior to develop	2	-2	0
	TOTAL SCORING			

Enter total score on QMM score sheet block e.

Figure 13.　Requirements Management YES/NO-N/A- Questions　(from: Machniak 99])

No.	Estimation/Planning Questionnaire	Yes	No	N/A
1	A volume product metric used (LOC, # of files, # of screens, pages of doc)	1	0	0
2	Measure used for various product elements (modules, components, CSCI)	1	0	0
3	Product measures made by phase (amt at implementation, LOC changed at unit test)	1	0	0
4	Other product attributes measured (FP, throughput, mem cap, cyclomatic complexity)	1	0	0
5	Product metrics tracked and updated throughout program execution	2	-1	0
6	Event count process metric used (# defects in test, reqmt changes, milestones met)	1	0	0
7	Time measure process metric used (cycle time)	1	0	0
8	Process metrics tracked and updated throughout program execution	2	-1	0
9	Program cost estimations made from product or process metrics	1	0	0
10	Program cost estimations tracked and updated to reflect progress/changes	1	0	0
11	Factor analysis performed on program	1	0	0
12	Program's primary purpose, including major functions and deliverables known	2	-1	0
13	Work breakdown structure developed	2	-1	0
14	Task estimated with realistic expectations of productivity probabilities	1	-1	0
15	Schedules developed based on realistic expectations	1	-1	0
16	Schedules tracked and updated based on new information	1	-1	0
17	Detailed activity lists used for clearly defined completed/not completed tasks	1	-1	0
18	Quality assurance plan or similar to aid in detecting defects early in program	1	-1	0
19	COCOMO estimates performed	1	-1	0
20	CSCI clearly defined and tasked	2	-1	0
21	Estimates completed ad hoc	-2	0	0
22	Gantt charts used and updated	1	-1	0
23	Resource estimations (working hrs, job categories, task activities) done	1	-1	0
24	Earned value established	2	-1	0
25	Earned value tracked throughout program	2	0	0
26	Quality expectations established for product with users and stakeholders	1	-1	0
27	Critical path for program tasks developed and tracked	2	-1	0
28	Meaure of effectiveness (MOE) or Figure of merit established and tracked	1	0	0
29	Estimates are updated routinely	2	-1	0
30	Schedules are updated routinely	2	-1	0
31	Estimations are made by program management (top-down)	1	0	0
32	Estimations are made by program team members (bottom-up)	2	0	0
33	Automated program tracking used	1	0	0
34	PM usually thorough in tracking and reporting schedules and financials	1	-1	0
35	WBS developed only as data call, not used in planning	-1	0	0
36	Earned value used to track program progress	2	-1	0
37	PM insists on prioritizing work reduction as schedule/funding compromised by stakeholders	1	-1	0
38	Estimations are done using both top down and bottoms up approaches	2	-1	0
39	All program team members involved in planning process	2	-1	0
40	Hardware also considered in estimation process	1	-1	0
41	Program history compiled	1	0	0
42	System upgrades (SCR) software changes requests estimated individually	1	-1	0
43	Management duties apart of each team member's responsibilities	-1	1	0
44	PM dictates schedules to program team	-1	0	0
45	Code reviews planned in schedule	1	-1	0
46	Defined tangible milestones established for program tasks	2	-1	0
47	Test planning done at the start of the program	1	-1	0
48	Estimations are completed by those performing the tasks	1	-1	0
49	Sensitivity analysis performed for program choices	1	-1	0
50	Software deployment planning completed	1	-1	0
	TOTAL SCORING			

Enter total score on QMM score sheet block f.

Figure 14.   Estimation/Planning Management YES/NO-N/A- Questions (from: Machniak 99])

Program Name_____ **YES-NO-N/A Questionnaire Scoring Template** Date_____

No.	People Management Questionnaire	Yes	No	N/A
1	PM is accessible in person by each team member	1	0	0
2	PM is accessible via email by each team member	1	0	0
3	PM is accessible via phone by each team member	1	0	0
4	PM not only considers a person's suitability, not also desire to be on a team	1	0	0
5	PM consults with each team member regarding their career goals	1	0	0
6	PM regularly holds meetings to inform team of program progress	2	-1	0
7	PM solicits opinions from team members before making decisions	2	-1	0
8	PM lets teams make decisions affecting their work	1	0	0
9	PM frequently makes decisions without any consultation with members	-2	2	0
10	PM understands the technology/language of the program	1	0	0
11	PM is able to communicate with other the technical issues in the program	1	-1	0
12	PM prioritizes problems or conflicts within the program	1	0	0
13	PM assists team members in developing/advising of career path	1	-1	0
14	PM empowers program members to recommend hiring new team members	1	-1	0
15	PM empowers program members to recommend firings of other members	1	-1	0
16	PM specifically assigns work to each program member	1	-1	0
17	PM sets communication protocol to be followed	1	0	0
18	PM allows unrestricted communications	1	0	0
19	PM readily makes tough decisions	1	-1	0
20	PM takes control in difficult/ problem areas	1	0	0
21	PM looks ahead to new programs, new upgrades of existing program	1	0	0
22	PM maintains regular communications with all stakeholders	2	-1	0
23	PM maintains regular communications with users	2	-1	0
24	PM encourages program team communication with users	1	-1	0
25	PM encourages program team communication with stakeholders	1	-1	0
26	PM facilitates horizontal communication within program	1	-1	0
27	PM facilitates communication during integration	1	-1	0
28	PM holds meetings without clear objectives listed prior to meeting	-1	2	0
29	PM must approve all decisions within the program	-1	1	0
30	PM must approve all interactions with stakeholders	-1	1	0
31	PM must approve all interactions with users	-1	1	0
32	PM makes all presentations to stakeholders/users	0	1	0
33	PM is considered "flexible" in terms of program members personal issues	1	0	0
34	PM, at least occasionally, schedules/promotes outside work team activities	1	0	0
35	PM is readily willing to listen to program problems and complaints	1	-1	0
36	PM takes action to resolve program problems and complaints	1	-1	0
37	PM is generally respected by stakeholders, users, and organization	1	-1	0
38	PM sometimes fails to grasp important technical issues in program	-1	1	0
39	PM recruits program team members from outside organization	1	-1	0
40	PM directs what needs to be done and directs how to do it	-1	1	0
41	Program personnel have clearly defined specific tasks	0	1	0
42	Although individual's tasks are specific, each exposed to the "bigger picture"	2	-1	0
43	PM has clearly defined his/her expectations for each individual	2	-1	0
44	PM delegation of duties is usually seemless in execution	1	0	0
45	PM acts as facilitator to solving personnel conflicts	2	-1	0
46	PM attempts to motivate individuals on the program team	2	-1	0
47	PM clearly separates technical from managerial roles for individuals	0	1	0
48	PM directs how he/she expects the task to be accomplished	0	1	0
49	PM directs what needs to be done, but does not direct how	2	-1	0
50	PM attempts to spotlight individuals in the program for positive exposure	2	-1	0
	TOTAL SCORING			

Enter total score on QMM score sheet block g.

Figure 15.   People Management YES/NO-N/A- Questions (from: Machniak 99])

No.	Risk Management Questionnaire	Yes	No	N/A
1	Risk Management (RM) is specifically an activity in the program	4	-4	0
2	RM is formal and documented	3	-3	0
3	A specific RM plan exists	2	-2	0
4	RM is required in the program, but not used during the program	-1	1	0
5	RM is done prior to the program execution	1	0	0
6	RM is done by an outside entity to the development	1	0	0
7	RM is done internally only	0	1	0
8	RM is both internally performed and externally assessed	1	-1	0
9	RM planning occurs during or after major milestones in the program	1	-1	0
10	Risk Assessment is only a management function	0	1	0
11	RM is informal or non existent	-1	1	0
12	There is a RM plan, but it is not updated or tracked	1	0	0
13	Risks are only generalized	-1	0	0
14	Each risk is delineated	1	0	0
15	Each risk has a consequence	1	0	0
16	Each risk has a likelihood rating of some sort	1	0	0
17	Each risk has a mitigation strategy	1	0	0
18	Risk Management is automated	1	0	0
19	Risks are tracked	2	-2	0
21	Regret analysis performed	2	0	0
22	RM drives decisions in the program	3	-2	0
23	Risks have probabilities	1	0	0
24	Risk Management is ad hoc	-3	0	0
25	RM information is shared with all stakeholders (as appropriate)	1	0	0
26	Risks are weighed relative to other program risks	1	0	0
27	Risk Assessment is a program team activity	1	0	0
28	Risk Assessment done prior to program start	2	-1	0
29	Risk Assessment includes personnel risk	1	-1	0
30	RM uses tools, but depends on human decisions	2	-1	0
31	Risk Assessment includes cost risks	1	0	0
32	Risk Assessment includes schedule risks	1	0	0
33	Risk Assessment includes technology risks	1	-1	0
34	Risk Assessment is briefed organization structure above program manager	1	-1	0
35	Risk Assessment includes requirements risks	1	-1	0
36	Risk Assessment includes user risks (too little involvement of user)	1	0	0
37	Risk Assessment includes documentation risks	1	0	0
38	Risk Assessment includes integration risks	1	-1	0
39	Risk Assessment includes interface risks (non-standard)	1	-1	0
40	Risk Assessment includes continuing requirements change (feature creep)	1	-1	0
41	Risk Assessment includes dependent projects/programs risks	1	0	0
42	Documentation proof exists to demonstrate following risk management plan	1	0	0
43	High risk have measured tracking (high profile status)	1	0	0
44	Organizational history used to search for risks	1	0	0
45	Other organizational checklists used for risk assessment	1	0	0
46	Internal organizational checklists used for risk assessment	1	0	0
47	Risk Assessment information contributed to internal or other database	1	0	0
48	Risk Assessment includes internal organization risks	1	0	0
49	Risk Assessment includes stakeholder risks	2	-1	0
50	No risk management needed; program is straightforwarded & understood	-3	3	0
	TOTAL SCORING			

Enter total score on QMM score sheet block h.

Figure 16.   Risk Management YES/NO-N/A- Questions (from: Machniak 99])

APPENDIX B – BLANK COMPARISON MATRIX

No.	Questions of the Quality Management Metric	Process Area Goal Evaluated				
	Questions of People Management Part					
P001	Long range organizational vision / Short term program and immediate work focus					
P002	Lead through personal attention to others / Action-oriented leadership approach					
P003	Run as much of the organization as possible / let team make decisions as much as possible					
P004	Direct and domineering style / Encourage independence of others					
P005	Traditional leaders respect hierarchy / Do what needs to be done					
P006	Win cooperation rather than demand it / Tough-minded with others					
P007	Act strongly and forcefully in the field of ideas / Prefer to lead other independent types while seeking autonomy for self					
P008	Consults with team members to find solutions to problems / Consults team members to get validation of program manager's (PM) predetermined solution					
P009	Keep people well informed / Only as much knowledge as necessary for their work					
P010	Make things happen by focusing on the immediate problem / Long range focus and de-emphasize current problem					
P011	Manage others loosely and prefer minimal supervision / Follow traditional procedures and rules conscientiously					
P012	Leadership, management decisions exclusively by PM / PM makes decisions but gets inputs from team					
P013	Team-program manager relationship adult-adult / Team-PM relationship parent-child					
P014	PM makes decisions but gets inputs from team / All program team members responsible for program decisions					
P015	When a problem arises: management takes over to solve it / Management lets the team solve the problems					
P016	Leadership is do as I say, not do as I do / Leadership by example					
P017	Program expectation not influenced by PM / Program expectation managed by PM					
P018	PM gives freedom to team, but does has no mentoring for leaders / PM empowers teams by mentoring members to be leaders					
P019	PM waits and sees what happens then plans / Management plans far in advance					
P020	PM is reacts to emergencies / Management is one step ahead of problems					
P021	Facilitative approach to solving problems / Take charge readily and often					
P022	PM is complex, takes much time to understand / Management is simple, easy to figure out					
P023	PM prefers to plunge right in / Takes time to separate things to be done and order of doing them					
P024	PM reacts to needs of the moment / Methodically follows plans					
P025	PM has technical experience particular to the particular s/w program / PM relies on team members solely					
P026	PM participates in technical reviews / PM only in non-technical reviews					
P027	PM participates in making technical decisions when problems arise / PM delegates technical questions					
P028	PM does not get involved discussing technical options / PM contributes to technical options when discussed					
P029	PM does not review technical options and decisions / PM reviews technical options and decisions					

No.	Questions of the Quality Management Metric	Process Area Goal Evaluated				
P030	PM actively attempts to keep up-to-date with current technology and standards / PM is removed from cutting edge technology issues					
P031	PM receives technical periodicals and occasionally references applicable articles / PM doesn't read periodicals nor references current articles to team					
P032	PM doesn't have technical background (or education) / PM has technical background (or education)					
P033	Team members avoid PM when they need technical advice / Team members generally consider talking to PM regarding technical issues					
P034	Program members have clearly defined, segmented roles / Work responsibilities are shared					
P035	Formal team building procedures are used / No formal team building is emphasized					
P036	Program manager flexible regarding work hours / Program manager maintains strict standards for work hours					
P037	Big picture conveyed to all team members by PM / PM focuses on the partitioned tasks with team					
P038	People issues dealt with primarily through indirect methods (email, memo etc) / People issues dealt with primarily through direct methods (face-to-face)					
P039	Training is required and planned on a regular basis / Training is ad hoc					
P040	Each team member is educated on and understands overall program and their roles / Team members only know their respective areas					
P041	Consideration for team members' career goals are reflected in assignments / Team members must adapt to tasks that are assigned					
P042	Team members assignments and responsibilities are mostly dictated by PM / Assignments and responsibilities are discussed and agreed upon with PM					
P043	Management leads in problem solving / Management facilitates and lets team lead in problem solving					
P044	Management welcomes problems as challenges and opportunities / Management views problems as obstacles and grounds for punishment					
P045	Team members participate in performance evaluations of peers / Personnel evaluations are strictly PM responsibility					
P046	Management reinforcement feedback sparse and inconsistent, if any / Management provides timely reinforcement feedback for positive behaviors					
P047	Management provides basic needs of office facilities fairly well / Office facilities are a drawback to working in the program					
P048	Working conditions are fairly comfortable, time off policy "flexible" / Working conditions and time off policy is inconsistent and difficult at times					
	People Management Part – YES-NO-N/A Questions					
P049	Communications primarily written (email, memo, etc.) / Communications primarily verbal (face-to-face)					
P050	Detailed instructions: oral presentation, follow-up email, memo, etc. / Email, memo, etc. only					
P051	Formal communication protocol / Informal communications					
P052	External vertical communications restricted / External vertical communication allowed					
P053	Coders notebook, weekly accomplishment reports required / Not required					
P054	User-coder relationship established, encouraged, and mediated / User-coder interaction minimized					
P055	Meetings structured to minimize wasted time / Meetings unstructured and open ended					
P056	Meetings have agenda, objectives, and conclude with action items / Meeting agenda fluid and open ended					
P057	PM and coder communication face to face / PM and coder communication primarily email					
P058	Program team updated regularly regarding organizational & program status / Meetings infrequently scheduled					

No.	Questions of the Quality Management Metric	Process Area Goal Evaluated				
P059	Open communications is encouraged / Communication through chain of command only is encouraged					
P060	Program manager is accessible for discussions / Program manager difficult to get an appointment to see					
P061	PM (PM) is viewed as separate from team / PM mixes with team frequently					
P062	Management regularly holds team meetings / Meetings are sporadic					
P063	Meetings are structured with definite goals and objectives / Meetings are informal					
P064	PM is generally easy to reach and talk to / PM is usually hard to get a hold of and difficult to talk to					
P065	Team-PM relationship adult-adult / Team-PM relationship parent-child					
P066	Schedules are spontaneous and poorly communicated / Schedules must be fixed and rigidly followed and formally reported					
P067	Work is seen as complex processes involving team working together / Work broken into pieces with minimal team member interaction					
P068	Action items sometimes are not followed through / Action items communicated and followed thoroughly					
P069	Team members require frequent clarifications by PM for assigned tasks / Team members rarely require clarifications by PM for assigned tasks					
P070	PM is accessible in person by each team member					
P071	PM is accessible via email (memo, letter) by each team member					
P072	PM is accessible via phone by each team member					
P073	PM not only considers a person's suitability, not also desire to be on the team					
P074	PM consults with each team member regarding their career goals					
P075	PM regularly holds meetings to inform team of program progress					
P076	PM solicits opinions from team members before making decisions					
P077	PM lets teams make decisions affecting their work					
P078	PM frequently makes decisions without any consultation with members					
P079	PM understands the technology/language of the program					
P080	PM is able to communicate with others the technical issues of the program					
P081	PM prioritizes problems or conflicts within the program					
P082	PM assists team members in developing / advising of career path					
P083	PM empowers program members to recommend hiring new team members					
P084	PM empowers program members to recommend firings of other members					
P085	PM specifically assigns work to each program member					
P086	PM sets communication protocol to be followed					
P087	PM allows unrestricted communications					
P088	PM readily makes tough decisions					
P089	PM takes control in difficult /problem areas					
P090	PM looks ahead to new programs, new upgrades of existing program					
P091	PM maintains regular communications with all stakeholders					
P092	PM maintains regular communications with users					
P093	PM encourages program team communication with users					
P094	PM encourages program team communication with stakeholders					
P095	PM facilitates horizontal communication within program					
P096	PM facilitates communication during integration					
P097	PM holds meetings without clear objectives listed prior to meeting					
P098	PM must approve all decisions within the program					
P099	PM must approve all interactions with stakeholders					
P100	PM must approve all interactions with users					
P101	PM makes all presentations to stakeholders / users					
P102	PM is considered "flexible" in terms of program members personal issues					
P103	PM, at least occasionally, schedules/promotes outside work team activities					

No.	Questions of the Quality Management Metric	Process Area Goal Evaluated				
P104	PM is readily willing to listen to program problems and complaints					
P105	PM takes action to resolve program problems and complaints					
P106	PM is generally respected by stakeholders, users, and organization					
P107	PM sometimes fails to grasp important technical issues in program					
P108	PM recruits program team members from outside organization					
P109	PM directs what needs to be done and directs how to do it					
P110	Program personnel have clearly defined specific tasks					
P111	Although individual's tasks are specific, each exposed to the "bigger picture"					
P112	PM has clearly defined his/her expectations for each individual					
P113	PM delegation of duties is usually seamless in execution					
P114	PM acts as facilitator to solving personnel conflicts					
P115	PM attempts to motivate individuals on the program team					
P116	PM clearly separates technical from managerial roles for individuals					
P117	PM directs how he/she expects the task to be accomplished					
P118	PM directs what needs to be done, but does not direct how					
P119	PM attempts to spotlight individuals in the program for positive exposure					
	Relevant Questions from the Risk Management Part					
R001	Risk Assessment includes personnel risk					
R002	Internal organizational checklists used for risk assessment					
R003	Personnel risks examined / No personnel risks examined					
R004	Risk management plan updated regularly					
R005	Risk Management is formal and documented / Risk Management is informal, if at all					
R006	Resource risks examined / No resource risks examined					
	Relevant Questions from the Estimation/Planning Management Part					
E001	Work breakdown structure developed					
E002	Task estimated with realistic expectations of productivity probabilities					
E003	Develop work breakdown structure / Assign work as needs arise					
E004	Resource evaluations made for program / No resource evaluations for planning					
E005	Estimates updated at reviews / Estimates constantly updates (in between reviews, too)					
E006	Work breakdown structure has objective measure of completeness					
E007	Training part of estimates / Training omitted in estimates					
E008	Team possibilities considered for planning of program / no consideration for outside teaming possibilities					

Table 1.   Blank Comparison Matrix

APPENDIX C – EVALUATED COMPARISON MATRICES

A. LEVEL 2: MANAGED

1. Process Area Staffing

- Goal 2.a.1: Individuals or workgroups in each unit are involved in making commitments that balance the unit's workload with approved staffing.

- Goal 2.a.2: Candidates are recruited for open positions

- Goal 2.a.3: Staffing decisions and work assignments are based on an assessment of work qualifications and other valid criteria

- Goal 2.a.4: Individuals are transitioned into and out of positions in an orderly way.

- Goal 2.a.5: Staffing practices are institutionalized to ensure they are performed as managed processes.

		2.a.1	2.a.2	2.a.3	2.a.4	2.a.5
P008	Consults with team members to find solutions to problems / Consults team members to get validation of program manager's (PM) predetermined solution	X				
P012	Leadership, management decisions exclusively by PM / PM makes decisions but gets inputs from team	X				
P014	PM makes decisions but gets inputs from team / All program team members responsible for program decisions	X				
P019	PM waits and sees what happens then plans / Management plans far in advance	X				
P020	PM is reacts to emergencies / Management is one step ahead of problems				X	
P024	PM reacts to needs of the moment / Methodically follows plans				X	X
P034	Program members have clearly defined, segmented roles / Work responsibilities are shared				X	
P035	Formal team building procedures are used / No formal team building is emphasized		X	X		
P042	Team members assignments and responsibilities are mostly dictated by PM / Assignments and responsibilities are discussed and agreed upon with PM	X				
P050	Detailed instructions: oral presentation, follow-up email, memo, etc. / Email, memo, etc. only				X	
P066	Schedules are spontaneous and poorly communicated / Schedules must be fixed and rigidly followed and formally reported	X				
P077	PM lets teams make decisions affecting their work	X				
P083	PM empowers program members to recommend hiring new team members		X			
P084	PM empowers program members to recommend firings of other members		X		X	
P108	PM recruits program team members from outside organization	X	X	X		
P111	Although individual's tasks are specific, each exposed to the "bigger picture"	X				
P112	PM has clearly defined his/her expectations for each individual			X		
P118	PM directs what needs to be done, but does not direct how	X				
R001	Risk Assessment includes personnel risk					X
R002	Internal organizational checklists used for risk assessment					X

		2.a.1	2.a.2	2.a.3	2.a.4	2.a.5
R003	Personnel risks examined / No personnel risks examined					X
R004	Risk management plan updated regularly					X
R005	Risk Management is formal and documented / Risk Management is informal, if at all					X
E001	Work breakdown structure developed			X		
E002	Task estimated with realistic expectations of productivity probabilities			X		

Table 2. Process Area Staffing

2. Process Area Communication and Coordination

- Goal 2.b.1: Information is shared across the organization

- Goal 2.b.2: Individuals or groups are able to raise concerns and have them addressed by management

- Goal 2.b.3: Individuals and workgroups coordinate their activities to accomplish committed work

- Goal 2.b.4: Communication and Coordination practices are institutionalized to ensure they are performed as managed processes

		2.b.1	2.b.2	2.b.3	2.b.4
P001	Long range organizational vision / Short term program and immediate work focus	X			
P009	Keep people well informed / Only as much knowledge as necessary for their work	X			
P037	Big picture conveyed to all team members by PM / PM focuses on the partitioned tasks with team	X			
P040	Each team member is educated on and understands overall program and their roles / Team members only know their respective areas	X			
P049	Communications primarily written (email, memo, etc.) / Communications primarily verbal (face-to-face)			X	
P051	Formal communication protocol / Informal communications				X
P055	Meetings structured to minimize wasted time / Meetings unstructured and open ended			X	
P056	Meetings have agenda, objectives, and conclude with action items / Meeting agenda fluid and open ended			X	
P058	Program team updated regularly regarding organizational & program status / Meetings infrequently scheduled	X			
P060	Program manager is accessible for discussions / Program manager difficult to get an appointment to see		X		
P061	PM (PM) is viewed as separate from team / PM mixes with team frequently		X		
P062	Management regularly holds team meetings / Meetings are sporadic	X	X		
P063	Meetings are structured with definite goals and objectives / Meetings are informal			X	
P064	PM is generally easy to reach and talk to / PM is usually hard to get a hold of and difficult to talk to			X	
P070	PM is accessible in person by each team member			X	
P071	PM is accessible via email (memo, letter) by each team member			X	
P072	PM is accessible via phone by each team member			X	
P075	PM regularly holds meetings to inform team of program progress	X			
P076	PM solicits opinions from team members before making decisions		X		
P077	PM lets teams make decisions affecting their work		X		
P078	PM frequently makes decisions without any consultation with members		X		

		2.b.1	2.b.2	2.b.3	2.b.4
P086	PM sets communication protocol to be followed				X
P087	PM allows unrestricted communications		X		
P095	PM facilitates horizontal communication within program			X	
P096	PM facilitates communication during integration			X	
P097	PM holds meetings without clear objectives listed prior to meeting			X	
P104	PM is readily willing to listen to program problems and complaints		X		
P105	PM takes action to resolve program problems and complaints		X		
P111	Although individual's tasks are specific, each exposed to the "bigger picture"	X			

Table 3.   Process Area Communication and Coordination

3.   **Process Area Work Environment**

- Goal 2.c.1: The physical environment and resources needed by the workforce to perform their assignments are made available.

- Goal 2.c.2: Distractions in the work environment are minimized.

- Goal 2.c.3: Work Environment practices are institutionalized to ensure they are performed as managed processes.

		2.c.1	2.c.2	2.c.3
P047	Management provides basic needs of office facilities fairly well / Office facilities are a drawback to working in the program	X		
P104	PM is readily willing to listen to program problems and complaints		X	
P105	PM takes action to resolve program problems and complaints		X	
R004	Risk management plan updated regularly			X
R005	Risk Management is formal and documented / Risk Management is informal, if at all			X
R006	Resource risks examined / No resource risks examined			X

Table 4.   Process Area Work Environment

4.   **Process Area Performance Management**

- Goal 2.d.1: Unit and individual performance objectives related to committed work are documented.

- Goal 2.d.2: The performance of committed work is regularly discussed to identify actions that can improve it.

- Goal 2.d.3: Performance problems are managed.

- Goal 2.d.4: Outstanding performance is recognized or rewarded.

- Goal 2.d.5: Performance Management practices are institutionalized to ensure they are performed as managed processes.

		2.d.1	2.d.2	2.d.3	2.d.4	2.d.5

		2.d.1	2.d.2	2.d.3	2.d.4	2.d.5
P008	Consults with team members to find solutions to problems / Consults team members to get validation of program manager's (PM) predetermined solution			X		
P044	Management welcomes problems as challenges and opportunities / Management views problems as obstacles and grounds for punishment			X		
P045	Team members participate in performance evaluations of peers / Personnel evaluations are strictly PM responsibility		X			
P046	Management reinforcement feedback sparse and inconsistent, if any / Management provides timely reinforcement feedback for positive behaviors	X	X		X	X
P053	Coders notebook, weekly accomplishment reports required / Not required		X	X		X
P066	Schedules are spontaneous and poorly communicated / Schedules must be fixed and rigidly followed and formally reported					X
P068	Action items sometimes are not followed through / Action items communicated and followed thoroughly					X
P089	PM takes control in difficult /problem areas			X		
P112	PM has clearly defined his/her expectations for each individual	X				
P115	PM attempts to motivate individuals on the program team			X		
P119	PM attempts to spotlight individuals in the program for positive exposure				X	
E004	Resource evaluations made for program / No resource evaluations for planning	X				X
E005	Estimates updated at reviews / Estimates constantly updates (in between reviews, too)		X			X
E006	Work breakdown structure has objective measure of completeness	X				X

Table 5.   Process Area Performance Management

5.   Process Area Training and Development

- Goal 2.e.1: Individuals receive timely training that is needed to perform their assignments in accordance with the unit's training plan

- Goal 2.e.3: Training and Development practices are institutionalized to ensure they are performed as managed processes.

		2.e.1	2.e.3
P039	Training is required and planned on a regular basis / Training is ad hoc	X	X
P040	Each team member is educated on and understands overall program and their roles / Team members only know their respective areas	X	
E007	Training part of estimates / Training omitted in estimates		X

Table 6.   Process Area Training and Development

B.   LEVEL 3: DEFINED

1.   Process Area Competency Analysis

- Goal 3.a.1: The workforce competencies required to perform the organization's business activities are defined and updated

- Goal 3.a.2: The work processes used within each workforce competency are established and maintained

- Goal 3.a.3: The organization tracks its capability in each of its workforce competencies

- Goal 3.a.4: Competency Analysis practices are institutionalized to ensure they are performed as defined organizational processes.

		3.a.1	3.a.2	3.a.3	3.a.4
P024	PM reacts to needs of the moment / Methodically follows plans		X		
P035	Formal team building procedures are used / No formal team building is emphasized		X		
P040	Each team member is educated on and understands overall program and their roles / Team members only know their respective areas	X			
P051	Formal communication protocol / Informal communications		X		
P053	Coders notebook, weekly accomplishment reports required / Not required			X	
P058	Program team updated regularly regarding organizational & program status / Meetings infrequently scheduled			X	
P069	Team members require frequent clarifications by PM for assigned tasks / Team members rarely require clarifications by PM for assigned tasks	X			
E001	Work breakdown structure developed				
R003	Personnel risks examined / No personnel risks examined				X
R004	Risk management plan updated regularly				X
R005	Risk Management is formal and documented / Risk Management is informal, if at all				X

Table 7.   Process Area Competency Analysis

2.   Process Area Workforce Planning

- Goal 3.b.3: Units perform workforce activities to satisfy current and strategic competency needs

- Goal 3.b.4: Workforce Planning practices are institutionalized to ensure they are performed as defined organizational processes.

		3.b.3	3.b.4
P001	Long range organizational vision / Short term program and immediate work focus	X	
P017	Program expectation not influenced by PM / Program expectation managed by PM	X	
P039	Training is required and planned on a regular basis / Training is ad hoc	X	
P040	Each team member is educated on and understands overall program and their roles / Team members only know their respective areas	X	
P066	Schedules are spontaneous and poorly communicated / Schedules must be fixed and rigidly followed and formally reported		X
P075	PM regularly holds meetings to inform team of program progress	X	X
P090	PM looks ahead to new programs, new upgrades of existing program	X	
E004	Resource evaluations made for program / No resource evaluations for planning		X
E005	Estimates updated at reviews / Estimates constantly updates (in between reviews, too)		X
E008	Team possibilities considered for planning of program / no consideration for outside teaming possibilities		X

Table 8.   Process Area Workforce Planning

3. Process Area Career Development

- Goal 3.d.2: Individuals pursue career opportunities that increase the value of their knowledge, skills, and process abilities to the organization.

		3.d.2
P041	Consideration for team members' career goals are reflected in assignments / Team members must adapt to tasks that are assigned	X
P074	PM consults with each team member regarding their career goals	X
P082	PM assists team members in developing / advising of career path	X
P119	PM attempts to spotlight individuals in the program for positive exposure	X

Table 9.   Process Area Career Development

4. Process Area Workgroup Development

- Goal 3.f.1: Workgroups are established to optimize the performance of interdependent work.

- Goal 3.f.2: Workgroups tailor defined processes and roles for use in planning and performing their work.

- Goal 3.f.3: Workgroup staffing activities focus on the assignment, development, and future deployment of the organization's workforce competencies

- Goal 3.f.4: Workgroup performance is managed against documented objectives for committed work.

- Goal 3.f.5: Workgroup Development practices are institutionalized to ensure they are performed as defined organizational processes.

		3.f.1	3.f.2	3.f.3	3.f.4	3.f.5
P017	Program expectation not influenced by PM / Program expectation managed by PM				X	X
P019	PM waits and sees what happens then plans / Management plans far in advance				X	
P034	Program members have clearly defined, segmented roles / Work responsibilities are shared		X			
P037	Big picture conveyed to all team members by PM / PM focuses on the partitioned tasks with team		X			
P040	Each team member is educated on and understands overall program and their roles / Team members only know their respective areas		X			
P053	Coders notebook, weekly accomplishment reports required / Not required	X			X	
P057	PM and coder communication face to face / PM and coder communication primarily email	X				
P058	Program team updated regularly regarding organizational & program status / Meetings infrequently scheduled	X				
P066	Schedules are spontaneous and poorly communicated / Schedules must be fixed and rigidly followed and formally reported				X	
P067	Work is seen as complex processes involving team working together / Work broken into pieces with minimal team member interaction	X				
P095	PM facilitates horizontal communication within program		X			

		3.f.1	3.f.2	3.f.3	3.f.4	3.f.5
P096	PM facilitates communication during integration		X			

<div align="center">Table 10.   Process Area Workgroup Development</div>

5.   Process Area Participatory Culture

- Goal 3.g.1: Information about business activities and results is communicated throughout the organization

- Goal 3.g.2: Decisions are delegated to an appropriate level of the organization

- Goal 3.g.3: Individuals and workgroups participate in structured decision-making processes

- Goal 3.g.4: Participatory Culture practices are institutionalized to ensure they are performed as defined organizational processes.

		3.g.1	3.g.2	3.g.3	3.g.4
P002	Lead through personal attention to others / Action-oriented leadership approach	X			
P003	Run as much of the organization as possible / let team make decisions as much as possible		X		
P004	Direct and domineering style / Encourage independence of others	.		X	
P008	Consults with team members to find solutions to problems / Consults team members to get validation of program manager's (PM) predetermined solution			X	
P009	Keep people well informed / Only as much knowledge as necessary for their work	X			
P012	Leadership, management decisions exclusively by PM / PM makes decisions but gets inputs from team		X	X	
P013	Team-program manager relationship adult-adult / Team-PM relationship parent-child		X		
P014	PM makes decisions but gets inputs from team / All program team members responsible for program decisions			X	
P021	Facilitative approach to solving problems / Take charge readily and often		X		
P037	Big picture conveyed to all team members by PM / PM focuses on the partitioned tasks with team	X			
P040	Each team member is educated on and understands overall program and their roles / Team members only know their respective areas	X			
P042	Team members assignments and responsibilities are mostly dictated by PM / Assignments and responsibilities are discussed and agreed upon with PM			X	
P043	Management leads in problem solving / Management facilitates and lets team lead in problem solving		X	X	
P054	User-coder relationship established, encouraged, and mediated / User-coder interaction minimized	X			
P058	Program team updated regularly regarding organizational & program status / Meetings infrequently scheduled	X			X
P059	Open communications is encouraged / Communication through chain of command only is encouraged	X			
P062	Management regularly holds team meetings / Meetings are sporadic	X			X
P065	Team-PM relationship adult-adult / Team-PM relationship parent-child		X	X	
P075	PM regularly holds meetings to inform team of program progress	X			X
P077	PM lets teams make decisions affecting their work		X		

		3.g.1	3.g.2	3.g.3	3.g.4
P078	PM frequently makes decisions without any consultation with members			X	
P095	PM facilitates horizontal communication within program	X			
P096	PM facilitates communication during integration	X			
P098	PM must approve all decisions within the program			X	
P109	PM directs what needs to be done and directs how to do it			X	
P112	PM has clearly defined his/her expectations for each individual	X			
P118	PM directs what needs to be done, but does not direct how		X		

Table 11.   Process Area Participatory Culture

C.   LEVEL 4: PREDICTABLE

1.   Process Area Empowered Workgroups

- Goal 4.b.1: Empowered workgroups are delegated responsibility and authority over their work processes.

- Goal 4.b.2: The organization's workforce practices and activities encourage and support the development and performance of empowered workgroups.

- Goal 4.b.3: Empowered workgroups perform selected workforce practices internally

- Goal 4.b.4: Empowered Workgroup practices are institutionalized to ensure they are performed as defined organizational processes.

		4.b.1	4b.2	4.b.3	4.b.4
P003	Run as much of the organization as possible / let team make decisions as much as possible			X	
P004	Direct and domineering style / Encourage independence of others	X			
P007	Act strongly and forcefully in the field of ideas / Prefer to lead other independent types while seeking autonomy for self			X	
P009	Keep people well informed / Only as much knowledge as necessary for their work		X		
P011	Manage others loosely and prefer minimal supervision / Follow traditional procedures and rules conscientiously			X	
P021	Facilitative approach to solving problems / Take charge readily and often	X			
P043	Management leads in problem solving / Management facilitates and lets team lead in problem solving			X	
P077	PM lets teams make decisions affecting their work	X			
P078	PM frequently makes decisions without any consultation with members	X			
P098	PM must approve all decisions within the program	X			
P112	PM has clearly defined his/her expectations for each individual	X			
P117	PM directs how he/she expects the task to be accomplished	X			
P118	PM directs what needs to be done, but does not direct how	X			
E001	Work breakdown structure developed				X
E003	Develop work breakdown structure / Assign work as needs arise				X

Table 12.   Process Area Empowered Workgroups

2.   Process Area Quantitative Performance Management

- Goal 4.d.1: Measurable performance objectives are established for competency-based processes that most contribute to achieving performance objectives

- Goal 4.d.2: The performance of competency-based processes is managed quantitatively

- Goal 4.d.3: Quantitative Performance Management practices are institutionalized to ensure they are performed as defined organizational processes

		4.d.1	4.d.2	4.d.3
P017	Program expectation not influenced by PM / Program expectation managed by PM		X	
P045	Team members participate in performance evaluations of peers / Personnel evaluations are strictly PM responsibility		X	
P046	Management reinforcement feedback sparse and inconsistent, if any / Management provides timely reinforcement feedback for positive behaviors		X	
P058	Program team updated regularly regarding organizational & program status / Meetings infrequently scheduled			X
P066	Schedules are spontaneous and poorly communicated / Schedules must be fixed and rigidly followed and formally reported	X		X
P083	PM empowers program members to recommend hiring new team members		X	
P110	Program personnel have clearly defined specific tasks	X		
P112	PM has clearly defined his/her expectations for each individual	X		
E002	Task estimated with realistic expectations of productivity probabilities	X		
E005	Estimates updated at reviews / Estimates constantly updates (in between reviews, too)			X
E006	Work breakdown structure has objective measure of completeness	X		

Table 13.   Process Area Performance Management

D.   LEVEL 5: OPTIMIZING

1.   Process Area Continuous Capability Improvement

- Goal 5.a.3: Workgroups continuously improve the capability of their workgroup's operating processes.

- Goal 5.a.4: The capabilities of competency-based processes are continuously improved.

- Goal 5.a.5: Continuous Capability Improvement practices are institutionalized to ensure they are performed as defined organizational processes.

		5.a.3	5.a.4	5.a.5
P001	Long range organizational vision / Short term program and immediate work focus	X		
P025	PM has technical experience particular to the particular s/w program / PM relies on team members solely		X	
P026	PM participates in technical reviews / PM only in non-technical reviews		X	
P027	PM participates in making technical decisions when problems arise / PM delegates technical questions		X	

		5.a.3	5.a.4	5.a.5
P028	PM does not get involved discussing technical options / PM contributes to technical options when discussed		X	
P029	PM does not review technical options and decisions / PM reviews technical options and decisions		X	
P030	PM actively attempts to keep up-to-date with current technology and standards / PM is removed from cutting edge technology issues		X	
P031	PM receives technical periodicals and occasionally references applicable articles / PM doesn't read periodicals nor references current articles to team		X	
P032	PM doesn't have technical background (or education) / PM has technical background (or education)		X	
P058	Program team updated regularly regarding organizational & program status / Meetings infrequently scheduled	X		
P090	PM looks ahead to new programs, new upgrades of existing program		X	
P104	PM is readily willing to listen to program problems and complaints		X	
P105	PM takes action to resolve program problems and complaints		X	

Table 14.   Process Area Continuous Capability Improvement

2.   Process Area Organizational Performance Alignment

- Goal 5.b.1: The alignment of performance among individuals, workgroups, units and the organization is continuously improved.

- Goal 5.b.2: The impact of workforce practices and activities on aligning individual, workgroup, unit, and organizational performance is continuously improved.

- Goal 5.b.3: Organizational Performance Alignment practices are institutionalized to ensure they are performed as defined organizational processes

		5.b.1	5.b.2	5.b.3
P045	Team members participate in performance evaluations of peers / Personnel evaluations are strictly PM responsibility	X		
P046	Management reinforcement feedback sparse and inconsistent, if any / Management provides timely reinforcement feedback for positive behaviors	X		
P115	PM attempts to motivate individuals on the program team	X		
E001	Work breakdown structure developed	X		X
E003	Develop work breakdown structure / Assign work as needs arise	X	X	X
E005	Estimates updated at reviews / Estimates constantly updates (in between reviews, too)		X	
E006	Work breakdown structure has objective measure of completeness		X	X

Table 15.   Process Area Organizational Performance Alignment

3.   Process Area Continuous Workforce Innovation

- Goal 5.c.2: Innovative or improved workforce practices and technologies are identified and evaluated.

- Goal 5.c.3: Innovative or improved workforce practices and technologies are deployed using orderly procedures

- Goal 5.c.4: Continuous Workforce Innovation practices are institutionalized to ensure they are performed as defined organizational practices.

		5.c.2	5.c.3	5.c.4
P030	PM actively attempts to keep up-to-date with current technology and standards / PM is removed from cutting edge technology issues	X		
P031	PM receives technical periodicals and occasionally references applicable articles / PM doesn't read periodicals nor references current articles to team	X		
P060	Program manager is accessible for discussions / Program manager difficult to get an appointment to see	X		
P079	PM understands the technology/language of the program	X		
P080	PM is able to communicate with others the technical issues of the program	X		
P104	PM is readily willing to listen to program problems and complaints	X		
P039	Training is required and planned on a regular basis / Training is ad hoc		X	X

Table 16. Process Area Continuous Workforce Innovation

D. QUESTIONS WITHOUT CORRELATION TO P-CMM

No.	Questions of the Quality Management Metric
P005	Traditional leaders respect hierarchy / Do what needs to be done
P006	Win cooperation rather than demand it / Tough-minded with others
P015	When a problem arises: management takes over to solve it / Management lets the team solve the problems
P016	Leadership is do as I say, not do as I do / Leadership by example
P018	PM gives freedom to team, but does has no mentoring for leaders / PM empowers teams by mentoring members to be leaders
P022	PM is complex, takes much time to understand / Management is simple, easy to figure out
P023	PM prefers to plunge right in / Takes time to separate things to be done and order of doing them
P033	Team members avoid PM when they need technical advice / Team members generally consider talking to PM regarding technical issues
P036	Program manager flexible regarding work hours / Program manager maintains strict standards for work hours
P052	External vertical communications restricted / External vertical communication allowed
P081	PM prioritizes problems or conflicts within the program
P085	PM specifically assigns work to each program member
P088	PM readily makes tough decisions
P091	PM maintains regular communications with all stakeholders
P092	PM maintains regular communications with users
P093	PM encourages program team communication with users
P094	PM encourages program team communication with stakeholders
P099	PM must approve all interactions with stakeholders
P100	PM must approve all interactions with users
P101	PM makes all presentations to stakeholders / users
P102	PM is considered "flexible" in terms of program members personal issues
P103	PM, at least occasionally, schedules/promotes outside work team activities
P106	PM is generally respected by stakeholders, users, and organization
P107	PM sometimes fails to grasp important technical issues in program
P113	PM delegation of duties is usually seamless in execution

No.	Questions of the Quality Management Metric
P114	PM acts as facilitator to solving personnel conflicts
P116	PM clearly separates technical from managerial roles for individuals

Table 17.   Questions without correlation to P-CMM

LIST OF REFERENCES

[BOEHM 81] Boehm, B.W., Software Engineering Economics, Prentice-Hall, Inc., 1981.

[BOEHM 87] Boehm, B.W., Increasing Software Productivity, IEEE Computer 20, 9 (1987), pp. 43-57.

[BRIGGS 93] Briggs-Myers, I., Introduction to Type, Consulting Psychologists Press, Inc., 1993.

[BW 01] Business Week, Rating the Management Gurus, October 15, 2001, [http://www.businessweek.com/bschools/content/oct2001/bs200110 15_3309.htm].

[CHATZOGLOU 96]
Chatzoglou, P.D, Macaulay L.A., A review of existing models for project planning and estimation and the need for a new approach, International Journal of Project Management 14,3 (1996), pp. 173-183.

[CURTIS 01] Curtis, B., Hefley, W., Miller, S., "People Capability Maturity Model Version 2.0" Technical Report CMU/SEI-2001-MM-01, Software Engineering Institute, Carnegie Mellon University, July 2001.

[DAU 03] Risk Management Guide for DoD Acquisition, Fifth Edition, Version 2.0, Defense Acquisition University, Department of Defense, June 2003.

[GAO 93] General Accounting Office Report IMTEC-93-13, Mission-critical systems: Defense attempting to address major software challenges, General Accounting Office, Washington, D.C., 1992.

[GROSSMANN 00]
Grossmann, Mary A., Validation of a Quality Management Metric, Masters thesis, Naval Postgraduate School, Monterey California, September 2000.

[HUMPHREY 95]
Humphrey, W.S., A Discipline for Software Engineering, Addison-Wesley Publishing Co., 1995.

[LIKERT 67] Likert, R., The Human Organization, McGraw-Hill, 1967.

[MACHNIAK 99]
      Machniak, Martin J., Development of a Quality Management Metric (QMM) Measuring Software Program Management Quality, Masters thesis, Naval Postgraduate School, Monterey California, December 1999.

[OSMUNDSON 02a]
      Osmundson, J. S. Michael J.B., Machniak, M.J., Grossmann, M.A., Quality Management metrics for software development, Information & Management 40,8 (Sept. 2003), pp. 799-812.

[OSMUNDSON 02b]
      Osmundson, J. S., Class Notes from Naval Postgraduate School Course IS4300 Software Project Management, Monterey, 2002.

[OUSDA 87] Office of the Undersecretary of Defense for Acquisition, Report of the Defense Science Board Task Force on Military Software, Department of Defense, Washington D.C., September 1987.

[PAULK 93] Paulk, M.C., Curtis, B., Chrissis, M.B., and Weber, C.V., The Capability Maturity Model for Software, Version 1.1, IEEE Software 10,4, (July 1993), pp. 18-27.

[PRESSMAN 93]
      Pressman, R., A Managers Guide to Software Engineering, McGraw-Hill, Inc., 1993.

[STSC 00]   Software Technology Support Center, Guidelines for Successful Acquisition Management of Software-Intensive Systems, Version 3.0, Department of the Air Force, Hill Air Force Base, Utah, May 2000.

[ULRICH 97] Ulrich, D., A new mandate for human resources, Harvard Business Review 76, 1 (1998), pp. 124-134.

[WELLINS 91]
      Wellins, R.S; Byham, W.C., Wilson, J.M., Empowered Teams: Creating Self-Directed Work Groups that Improve Quality, Productivity, and Participation, San Francisco, Jossey-Bass, 1991.

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